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THE RUSSIAN PETROLEUM INDUSTRY.

BAKU can furnish apparently inexhaustible quantities of crude petroleum at a few pence per ton, and supply kerosene, equal to the best American refined oil, for a penny a gallon. It is in this that the whole importance of the petroleum question in Russia lies. Baku has a richer supply of crude oil than America; she can turn out enormous quantities of cheap kerosene; throughout the whole of Europe the markets are in a most receptive condition for refined petroleum oil—the problem is to bridge over the chasm between Baku and the markets of Europe. If this can be cheaply and efficiently done, there can be hardly a doubt that the American oil will have a very bad time of it.

Until last year Baku was isolated from the rest of Europe; a long and troublesome journey was needed in order to get to it. Affairs have now changed; Baku is linked by steam communication with every part of Europe, and all that is required is a development of the resources of that communication to place the oil in most of the lamps of the Continent.

What may be done in this respect is indicated in the career of the great oil carriers, Nobel Brothers, the history of whose rise constitutes a most interesting chapter in the industrial progress of Russia. If we describe that career, we shall do more to show what can be done at Baku than by any amount of speculative writing.

The firm comprises three Nobels—Ludwig, Robert, and Alfred—and is known in Russia under the title of Nobel Brothers Petroleum Production Company ("*Tovarishchestvo Nephtanavo Proisvodstva Bratieff Nobel*"). The father, Emmanuel Nobel, was the inventor of the torpedo, the secret of which he took from Sweden to St. Petersburg in 1838, and sold to the Russian Government.

Under his supervision were manufactured those torpedoes, submarine mines, or infernal machines, as they were frequently called then, which proved so troublesome to our fleet while blockading Cronstadt during its stay in the Baltic. When the war broke out, Emmanuel Nobel had an engineering works on the Neva, in which both his sons, Robert and Ludwig Nobel, were employed, and after they had co-operated in manufacturing and laying down the mines, they proceeded to construct engines for the large fleet of gunboats and men-of-war the Russian Government built at St. Petersburg and Cronstadt the second year of the hostilities.

This was not an easy task. Skilled labor was not obtainable in Russia at the time, and the Nobels had not only to design and supervise the construction of the engines, but also to work with and train up the men. After the cessation of naval activity at the close of the war, they built and engined nearly fifty steamers for the Volga, many of which are running to-day.

By the year 1860 the engineering works had developed into an extensive establishment—one of the largest in Russia—and in anticipation of lucrative Government contracts, Emmanuel Nobel sank a considerable amount of capital in still further extending it. But a period of retrenchment ensued, the promises of orders were not realized, and in the end the firm suspended operations.

The father retired with broken fortunes and broken health to Sweden, to die there, and the prospect seemed black indeed for the three sons, although two of them are now millionaires. But if their capital was gone, they retained what was ultimately destined to rebuild their fortunes—an unexceptionally vigorous and practical engineering training.

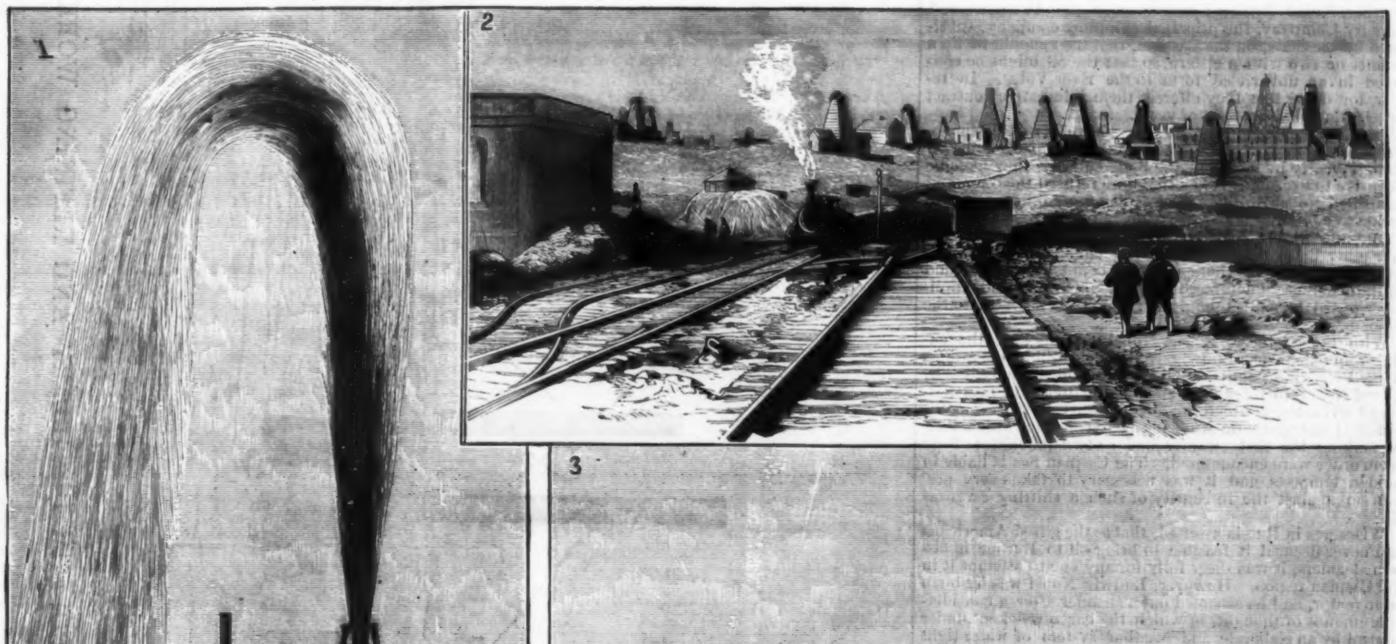
The manufacture of the submarine mines, and the laying of them down in the roadsteads of Cronstadt and Sveaborg, had taxed the ingenuity of the Nobels for months together. After the war, for years they had been engaged making steamers and machinery at a period when improvements were outracing one another, and it was no easy matter to keep apace with the times. Ludwig Nobel, in particular, enjoyed great reputation for engineering skill, and when the firm became bankrupt he was asked by the creditors to continue carrying on the works for a time as manager. Robert Nobel went to Germany, and in course of time began to take an interest in the petroleum industry, the rapid development of which in America was then the talk of Europe. Alfred Nobel applied himself entirely to chemical pursuits, and after a while discovered dynamite, the explosive that has since revolutionized warfare and shaken thrones, and rendered him a millionaire.

Ludwig Nobel carried on the business for the creditors for a couple of years, and then, with £500 saved during the interval, began life on his own account. Establishing a small engineering works, he took a series of contracts from the government for casting shot and shell, converting guns, and manufacturing rifle stocks, which rapidly carried him on to affluence.

It has been said that he rendered himself a millionaire exclusively through Baku petroleum. This is a mistake. When his brother Robert, enamored at what he had seen of the industry during a journey to the Caucasus in 1874, in search of walnut wood for the rifle stocks manufactured by Ludwig Nobel, urged him to co-operate in the enterprise, the latter was already worth £400,000 realized during his twelve years' operations. Aided with capital by his brother, Robert Nobel began operations as a petroleum refiner in a small way at Baku in 1875.

At that time there were more than 120 refineries at Baku, and hence he started in face of as severe a competition as any pessimist capitalist might expect to find to-day. The Swede did not concern himself, however, with concessions, subsidies, and other similar crutches dear to the heart of the company promoter. He simply settled down in an ordinary way at Baku, as any quiet, plodding capitalist might from England to-morrow; and commenced the campaign, conscious that success lay in replacing the desultory, primitive, and wasteful operations of the native firms with the resources of engineering, chemistry, and commercial organization.

As soon as Robert Nobel began to refine the crude oil from



1. A Petroleum Fountain during the First Five Days. 2. The Petroleum Wells. 3. The Harbor of Baku.

THE PETROLEUM WELLS OF BAKU, ON THE CASPIAN SEA.

the wells at Balakhani, he revolted against the practice of carrying the oil in barrels as being slow, wasteful, and costly. The other firms would not consent to co-operate in laying down a pipe-line, however, and Ludwig Nobel had to be applied to. For £10,000 a pipe was laid down eight miles long, from Balakhani to the Black Town of Baku, and paid its expenses the first season.

This gave Robert and Ludwig Nobel a widespread reputation at once, and by inciting other firms to do the same, laid the basis of the modern activity and enterprise at Baku. Having got their refinery in working order and a pipe-line laid down, the Nobels began to think of securing their own oil supply. Ground was purchased, and borers brought from America. At first they were singularly unsuccessful, and even sought to retrieve their ill-luck by boring in the island of Tcheleken, on the opposite side of the Caspian, but ultimately their wells suddenly proved productive, and since then they have always had more crude oil on hand than they have known what to do with.

In the mean while a fresh problem had arisen requiring to be solved, and this brings us, after a long introduction, to our subject of distribution. When the Nobels had refined their oil, they had to send it in barrels to the Russian market, 1,000 to 2,500 miles away. This was a very inconvenient and costly mode of transport.

In the first place there was no wood in the locality to make barrels of, and to bring it from the Volga occasioned a serious expense. Barrels were so expensive that many firms purchased the empty American ones for Baku, and even then the barrel was considerably dearer and more valuable than the oil it conveyed to market.

In the second place, owing to the extreme dryness of the Caspian region half the year round, the leakage from the barrels was very great, and in the third, the steamboat and railway companies exacted heavy freights for conveying the inconvenient barrels to Russia. To do away with them altogether, Nobel Brothers suggested to the Caucasus and Mercury Company, the principal shipping company, subsidized by the State, on the Caspian, that they should fit up a steamer or two with a cistern, so that the oil might be conveyed in an unbarreled form to the river Volga. In return for doing this they offered them a lucrative contract for carrying oil for a term of years.

The Caucasus Company, however, have always been notorious for want of enterprise. Making a handsome percentage yearly by means of the State subsidy, they have no incentive to exertion. They therefore refused the offer, and compelled Nobel Brothers, in default of any other means, to decide to construct a fleet of steamers themselves.

And now were displayed the advantages they possessed over other Baku firms in owning an engineering establishment on the Neva, where steamers could be planned and built, machinery manufactured, and apparatus and appliances tested by skilled engineers before being sent to the Caspian.

With the engineer, Robert Nobel, on the spot, the engineer and financier, Ludwig Nobel, controlling operations at St. Petersburg, and the talented chemical investigator, Alfred Nobel, to refer to in chemical matters, the firm possessed advantages which rendered serious rivalry from ill-educated and apathetic Russians or Armenians impossible. In making the first steamer one or two difficulties of no mean order were encountered. The Caspian Sea is liable to sudden tempests, and it was necessary to take every precaution against the insecurity of such a shifting cargo as oil.

Wiseacres in Russia asserted, that as the gifted Americans had never deemed it feasible to bring oil to Europe in cistern steamers, it was sheer folly for any one to attempt it in the Caspian region. However, Ludwig Nobel was by birth an inventor, and he schemed out a steamer after a considerable amount of thought, in which the cargo was kept under control by an elaborate and peculiar system of water-tight compartments, without in any way interfering with the rapid loading or unloading of the vessel. The trial steamer proved a complete success.

As might have been expected, it paid for itself the first season. Having got the start, the Nobels kept it up. They added to their fleet as fast as they could, getting the steamers cheaply constructed in Sweden. The profits were relatively enormous. With their steamers they beat the barrel transport so completely that the other firms had no chance against them, and as the profits were swiftly applied to extending the business, the company in a few short years became a gigantic concern.

The first "liquid transport," or "cistern steamer," appeared on the Caspian in 1879. There are now probably fifty. Nobel Brothers possess twelve—the Mahomet, Tatarin, Bramah, Spinoza, Darwin, Zoroaster, Talmud, Koran, Calmuck, etc. The dimensions of the Spinoza will give some idea of the class of steamer composing the fleet. The vessel is steel built, 245 ft. long, 27¾ ft. broad, and when laden with kerosene has a draught of 11 ft. The engines are of 120 nominal horse-power, steaming at 10 knots. They burn petroleum fuel, the bunkers containing a supply calculated to last six days, *i. e.*, sufficient for the journey from Baku to the mouth of the Volga and back. The cistern-hold accommodates 750 tons of kerosene each trip.

Some of the other vessels vary slightly from these dimensions. The Koran and Talmud are each 252½ ft. long and 28½ ft. broad, and carry passengers as well as oil.

Owing to the splendid canal system connecting the Neva with the Volga, very little trouble was experienced in conveying the Swedish steamers to the Caspian. In the case of the larger ones they were cut amidships to facilitate the passage; the open extremities being filled with iron bulkheads before entering the canals, and the vessel being put together again at Astrakhan.

Altogether, Nobel Brothers have sunk over £400,000 in establishing their petroleum fleet, and possess a regular dockyard at Astrakhan to repair them and the flotilla of smaller steamers on the Volga.

Directly Ludwig Nobel's cistern steamers proved a success, other firms hastened to purchase similar ones for the Caspian.

In the summer of 1882 one of these companies dispatched to the Caspian the first of a series, called the Merv, constructed at Crichton's Works at Abo, in Finland. The Merv is the same kind of vessel as the Spinoza, but somewhat smaller, being 216 ft. long, 28 ft. broad, and 9 ft. deep, possessing engines of 220 nominal horse-power, steaming at 9 knots, and having cabin accommodation for forty passengers as well as cistern holds for oil.

The Batoum, another vessel belonging to the same company, was 225 ft. long and 28 ft. broad. Rather smaller was a third steamer, the Surakhani, built at Abo for the Kokereff Company. This was 200 ft. long, 28 ft. broad, 9 ft. deep, steaming at 10½ knots, carrying 500 tons of oil at a trip, and costing £15,000 to construct.

MESSRS. NOBEL BROTHERS' PETROLEUM DISTILLERY AND REFINING WORKS, BAKU.

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In excess of these Swedish and Finnish steamers, Messrs. Mitchell & Co. have built several, and sent them from the Tyne to the Caspian Sea, chiefly for Fedoroff, Pavloff & Co., a firm that became bankrupt last year, through over speculation and mismanagement of affairs. The shipbuilders on the river Volga have also not been idle. The Rybinsk Engineering Works of Jooravieff have constructed for the Drujina Steamboat Company the Sheksna, a vessel 215 ft. long, 32 ft. broad, and 14 ft. deep, with engines of 75 nominal horse-power, steaming at eight knots and carrying over 500 tons of oil in cisterns and 25 tons in casks. These large steamers have all been utilized for the Caspian transport service.

The mouth of the Volga is too shallow to allow of the passage of steamers of large draught. Following the old practice of the passenger and cargo vessels, the oil is sent in these large steamers to the 9 ft. shallows at the mouth of the Volga. Here the oil is pumped into light-draught cistern steamers, or into large barges, and tugged up the river. This has involved the formation of a second flotilla.

The vessels of this flotilla range in size from 60 ft. to 150 ft., and convey the oil from the 9 ft. shallows to Tsaritzin, the first railway point on the river Volga. Nobel Brothers have about a dozen such vessels, costing £6,000 or so apiece, besides 11 iron tanks, barges for kerosene, four wooden ones fitted with 128 iron tanks, and 28 wooden barges for the liquid fuel.

Thanks to these vessels, the oil can be conveyed from Baku to Tsaritzin with wonderful rapidity. From the storage reservoirs at the refinery at Baku, the kerosene descends by its own gravity to the head of the pier on the bay, and pours into the cistern steamer at the rate of 100 tons per hour. The steamer then proceeds to the mouth of the Volga, pumps the oil into the barges, and returns again with water ballast, the journey there and back being done in 4½ days. Water being scarce at Baku, and in fact more precious than oil, it is pumped from the steamer into reservoirs, and is either used at the refinery, or for irrigating Villa Petrolia, the park which Ludwig Nobel is having laid out for his employes on the shore of the bay a short distance northeast of the refinery.

In the mean while, the smaller steamers run the oil up the Volga to Tsaritzin in a couple of days, and pump it into the reservoirs for storage alongside the railway, from which it is ultimately sent to every part of the Russian railway system, and to Middle and Western Europe.

The employment of these cistern steamers in place of barrels has wonderfully cheapened the price of oil in Russia, and given an impetus to the trade which this year is to be met by the addition of nearly a score of new steamers to the Caspian oil trade, of which fifteen will be from Sweden. All these oil steamers burn nothing but petroleum fuel, and considering the character of their cargo it is obvious that if for years past thousands of voyages have been performed by steamers laden with kerosene, with perfect immunity from fire, liquid fuel can be safely employed on other and ordinary vessels, having less combustible cargoes on board. The employment of oil fuel in the Caspian is no new thing, although Europe is only now beginning to discuss the merits of it.

The steamers began to burn it a dozen years ago, and the fuel has proved its excellence to such a degree that at present there is not a vessel on the Caspian using wood or coal. General Valentine Baker, who traversed the Caspian in 1873, predicted even then, with his accustomed sagacity, a great future for it. In his "Clouds in the East" he says: "The fuel is not highly inflammable, and its use seems perfectly safe and under control. Vessels originally fitted for burning coal can burn this liquid fuel with very little alteration. One stoker is sufficient for a large steamer. All the engineers of vessels burning petroleum speak in the highest terms of the fuel."

Since he visited the Caspian, Mr. Arthur Arnold, M.P., Colonel Stewart, Mr. O'Donovan, Consul Peacock, and a number of other Englishmen of greater and lesser note have seen these steamers at work on the sea, and all have spoken in terms of unqualified praise of liquid fuel. But perhaps the most satisfactory testimony is afforded by the fact that the use of the oil is becoming common even in the higher part of the Volga, where wood is tolerably plentiful. Altogether, probably not less than 300 steamers on the Volga and Caspian burn nothing but oil fuel to-day. Various kinds of pulverizers are used, the general principle being to mingle the oil refuse with a jet of steam and inject it into the furnace in the form of spray, where it makes a powerful and steady blaze.

The advantages of the fuel are such as to render competition on the part of wood or coal hopeless. To start with, one ton of oil refuse will do the work of two tons of coal even in the most wasteful apparatus in use on the Caspian, and of three tons in the more perfect Walker furnace. Less fuel being required, and the oil further taking up, weight for weight, less room than coal, a greater amount of space is available for cargo. Then no stoking is required, one man being sufficient to look after all the furnaces; the fuel is smokeless, a very important consideration for vessels of war; there is no banking of fires, the flame being turned on and off like an ordinary gas jet; and, finally, the fire can be regulated to any degree of intensity by simply adjusting the injector.

In the case of the vessels running from Baku to the mouth of the Volga, the engineers turn on the flame in starting, and concern themselves no more about their fires until they get to their destination in two days' time. The experience of a dozen years has rendered the Russian Admiralty so satisfied with liquid fuel, as used on board the ten or twelve steamers and gunboats of the Caspian fleet, that it has recently taken steps to fit up one or two vessels in the Black Sea to burn the oil refuse. Thanks to the railway connecting Batoum with Baku, it can transport to the Black Sea more than sufficient liquid fuel to render its fleet there independent of English coal.

Measures are already being undertaken to carry this into effect. The Minister of Marine, who recently visited Baku, has arranged for the Caspian fleet to be combined with that of the Black Sea, and the liquid fuel resources of the Baku dockyard to be placed at the disposition of the naval authorities at Sevastopol and Nicolaeff. In this manner, we shall probably see a number of vessels using liquid fuel in the Black Sea in a few years' time, and once the supply of oil fuel becomes abundant and cheap at Batoum, it must prove a formidable competitor with English mineral fuel in the Mediterranean, Egypt, and the East.—*Engineering.*

ANTI-GALACTAGOGUE.—To check the secretion of milk, Dr. Verrall (*British Medical Journal*) recommends iodide of potassium, eight grains, and quinine sulphate, twenty-three grains, three times a day.

MANUFACTURE OF VASELINE AND OTHER INDUSTRIAL RESIDUES FROM PETROLEUM.

CRUDE petroleum, as it comes to us from America, has to be submitted to distillation in order that its constituent parts may be utilized. This distillation gives, in the first place, ethers or light oils; in the second, oils that are employed for lighting, and lastly, heavy oils. If the distillation is not carried on to dryness, there remain in the bottom of the still, thick residues of a brown color, which have a greenish reflection and a strong and disagreeable odor. These are petroleum tars, and are employed in the industries for different purposes. Sometimes they are submitted to a new distillation at a high temperature for the purpose of extracting a further quantity of illuminating oil from them, and in this case coke is obtained as a final product. Sometimes, mixed with coal or sawdust, they serve for manufacturing artificial fuel; and, properly treated, they yield a gas fit for lighting purposes. To these different modes of utilization there has recently been added a new one, that gives these tars an unexpected value. This is the conversion of these materials into a product of fatty appearance that has been improperly designated as *mineral grease*—a name that commercial usages oblige us to adopt, but that is sometimes replaced by the terms *petreoline, vaseline,* etc. This material is sometimes white, sometimes straw-yellow or orange-yellow, and sometimes green, according to its degree of purification. It is unctuous to the touch, and its consistency recalls that of butter. It is translucent, inodorous, and tasteless, provided it has been well purified. Its melting-point varies between 30° and 36° C., according to the degree of concentration of the tar from which it is made. Its density varies with its degree of purification between 0·84° and 0·86°. It boils at a heat above 300°, and distills without residue in separating into mineral oil and paraffine. This new material, however, although it has all the appearance of the fatty matters, has none of those chemical properties that often render the latter difficult to use, especially in mechanics. It is not saponifiable, it does not become rancid, it is insoluble in water, but dissolves in the proportion of 20 to 100 in boiling alcohol of 95°, and partially in ether. It is entirely soluble in sulphide of carbon, chloroform, essences of petroleum, and spirits of turpentine, and the vegetable and animal oils and fats. Melted with glycerine, it solidifies the latter upon cooling. It is a carburet of hydrogen whose chemical composition approaches that of paraffine. This mineral grease was first obtained by the Americans through the purification of petroleum tars, and it is they who gave it the name of *vaseline*. The process by which it was first prepared consisted in submitting the tar to the action of a temperature varying from 150° to 160°, from 24 to 60 hours, according to the nature of the material acted upon, in order to expel from it all its empyreumatic products and odorous principles. The operation was performed in the open air, with naked fire, or, what was preferable, with a sand-bath (Fig. 1). The temperature was gradually raised, and then kept at the degree stated above until the deodorization was complete. The product thus obtained was then made to undergo a preliminary filtration through coarse bone-black in stoves kept at a temperature of from 40° to 50° (Fig. 2). There was thus obtained from 7 to 8 per cent. of a white grease, and then products that were more or less colored according to the quality of the bone-black employed; and these latter products were afterward submitted to a second filtration analogous to the first, and so on.

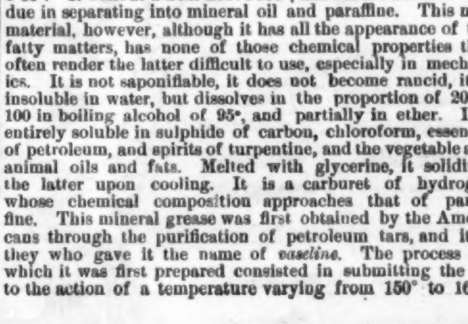


FIG. 1.—SAND BATH.

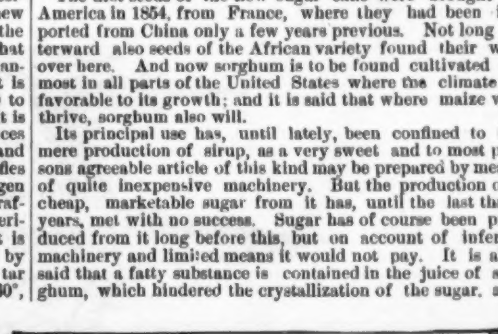


FIG. 2.—FILTRATION OF VASELINE.

Such a mode of manufacture presented, as may be seen, great difficulties, the result of which was to oblige manufacturers to sell their product at a high price. The first process, having been introduced into France a few years ago, soon received in this country certain improvements, and the price of vaseline gradually came down from 12 or 15 to 7 and even 6 francs per kilogramme. Such a price, however, was still too high to permit of a universal use of a product which, at a lower one, would have added to the industries in general valuable resources that were as yet unknown.

Recently, a French manufacturer, Mr. C. Cogniet, has discovered a new process of treating petroleum tars, and of extracting a mineral grease to which he has given the name of *pimeleine*. Obtained by this process, the mineral grease can be offered at a price that will hereafter bring it within the reach of the industries, and that will not exceed, for the white product, 3·5 francs per kilogramme. The few details that the inventor has had the kindness to communicate to us will suffice to show the advantages that his process presents over the one that has hitherto been followed.

The deodorization of the tar is effected in a closed vessel, and thus all danger of fire is avoided. For bone-black, Mr. Cogniet substitutes a special decolorizer whose cost is lower, and which, moreover, permits of the production of white grease being doubled in amount. In this process the tars are not submitted to the action of any chemical product, and for this reason an absolutely neutral material is obtained that does not oxidize metals—a valuable quality not possessed by artificial mineral greases sold under other names and made up of mixtures of mineral oils and waxes that have undergone a preliminary treatment with acids and alkalies.

Mineral grease (*vaseline, pimeleine,* etc.), when it is white, is employed in pharmacy as an advantageous substitute for lard in numerous preparations. The straw-yellow product is employed in perfumery and veterinary medicine. The orange-yellow and the green products are used for lubricating machines and greasing arms, polished pieces of metal, and objects of leather, which latter they penetrate, render pliable, and make impermeable to water without interfering, as other fatty bodies do, with the application of wax to the leather.

Finally, the beet sugar industry is utilizing this product for destroying the froth that is produced during the operation of carbonizing the saccharine juices.—*Science et Nature.*

SORGHUM SUGAR.

By OSCAR HOUCK, Ph.G.

THE different kinds of sorghum (Sorghum saccharatum) now under cultivation in the United States are varieties and hybrids from two main groups; the one the Chinese sugar cane, or sorgho, or sorghe, from China and India, and the second the African sugar cane, or imphee, from the south of Africa. As varieties of the first group, we have the regular sorghum, Honduras cane, honey top, sprangle top, etc. Of the second group the most important are the Liberian imphees, white African, white mammoth, Iowa red top, and wolf's tail. As hybrids, the early amber is the most common, early orange and a number of others. These hybrids need, as also their names indicate, a shorter time to obtain maturity, and are therefore especially adapted for the more northern range, Wisconsin, Minnesota, etc., where the season is rather short; while the countries further south, with a longer season, have the advantage that they can utilize both the early and late varieties, and thus be able to supply the mills for a longer time; besides that they also can utilize the other qualities, desirable in good cane, as saccharine richness, large percentage of juice, and large stalks. A rather sandy loam is said to be the most favorable soil for its cultivation.

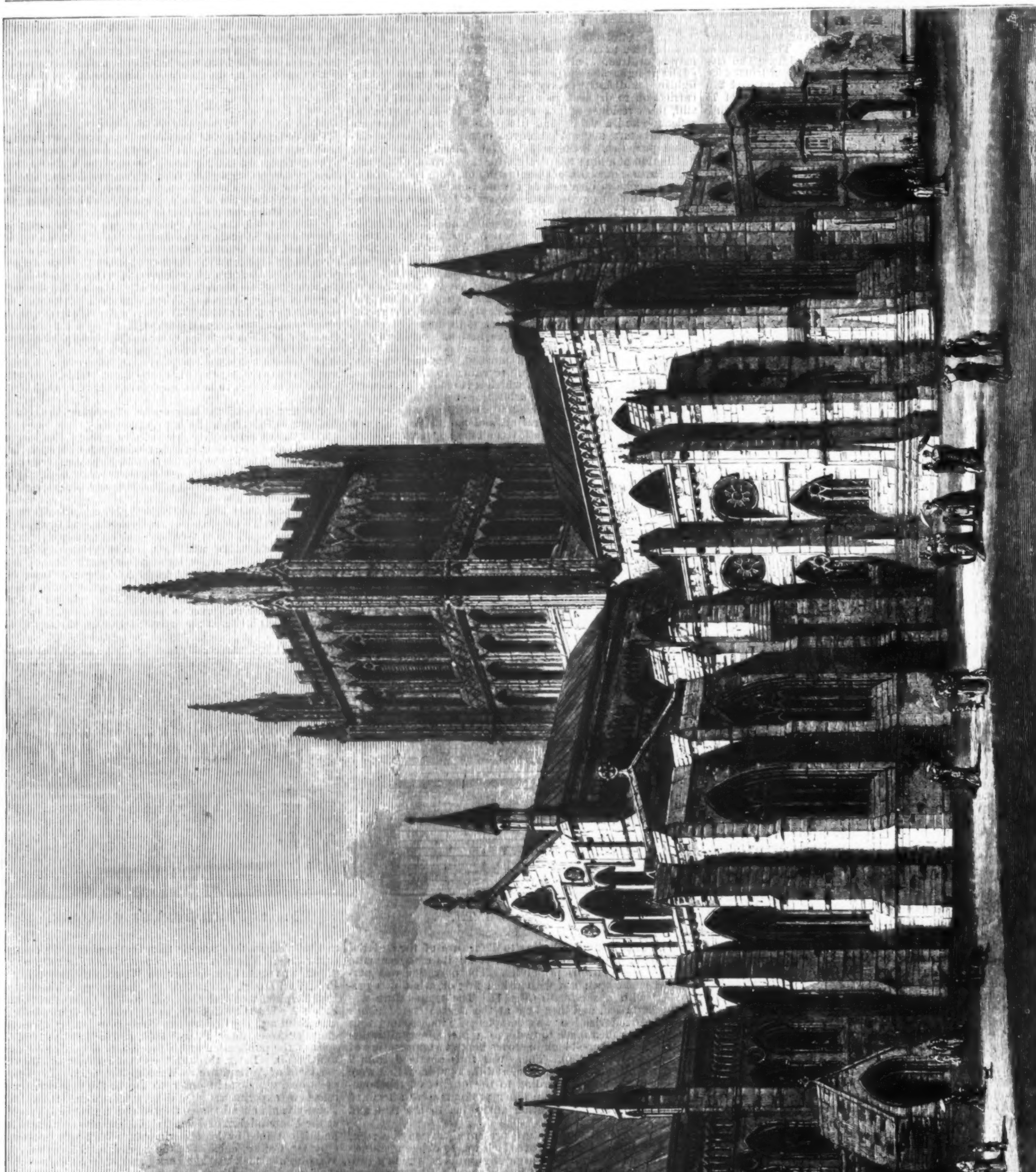
The first seeds of the new sugar cane were brought to America in 1854, from France, where they had been imported from China only a few years previous. Not long afterward also seeds of the African variety found their way over here. And now sorghum is to be found cultivated almost in all parts of the United States where the climate is favorable to its growth; and it is said that where maize will thrive, sorghum also will.

Its principal use has, until lately, been confined to the mere production of sirup, as a very sweet and to most persons agreeable article of this kind may be prepared by means of quite inexpensive machinery. But the production of a cheap, marketable sugar from it has, until the last three years, met with no success. Sugar has of course been produced from it long before this, but on account of inferior machinery and limited means it would not pay. It is also said that a fatty substance is contained in the juice of sorghum, which hindered the crystallization of the sugar, and necessitated another process than that used for the common sugar cane. The first sugar reported obtained from sorghum was made by a farmer in Wisconsin (according to Prof. Carl Mohr). In 1858, J. S. Levering, a chemist of Philadelphia, received the gold medal from the United States Agricultural Society, as an acknowledgment for his successful and meritorious experiments in sugar from sorghum ("Amer. Jour. Phar.," 1855, p. 182; 1858, p. 105). In spite of the publication of his process, no attempt was made to utilize it. Later, through the Commissioner of the Department of Agriculture at Washington, G. W. Le Duc, a great deal was done in order to arouse the interest for it, that new experiments should be undertaken. Steward, a Pennsylvania chemist, also treated the subject, and showed at the Centennial Exhibition, in 1876, samples of sugar which he had obtained by his experiments. With still greater energy Dr. Collier, chemist of the Agricultural Department at Washington, took up the work, and of the results of his thorough investigations he has given a minute account in his several reports, which has thrown much light on the subject.

At the same time, Prof. Swenson, of the University of Wisconsin, was occupied with investigations of the same kind, and when the United States Government, through the Agricultural Department at Washington, offered a prize of $1,200 for the best method of treating sorghum cane, it was awarded to him.

Some New York capitalists, after having corresponded with Prof. Swenson and secured his service, determined to establish a sugar mill in some portion of the country where the cane could be grown successfully and cheaply. The Arkansas River Valley was decided upon, and in 1882 the mill was built at Hutchinson, Kansas. As an experiment some sugar was successfully made, already late, the same season. Last fall (1883), they made as an average 40 barrels of sugar and about 200 gallons of sirup a day. This was the first undertaking on a large scale, and as it proved a success, others have followed their example, and many more are likely to follow.

The process used in the above named mill I have not seen myself, but will give it as it has been described. The cane, having been examined by the chemist and found in the desirable ripe condition (when it contains most saccharose and least glucose), is cut, topped, and hauled to the mill without stripping. Arrived there it is placed on a long endless belt, which acts as an elevator to carry it to the crusher, which consists of huge iron rollers. The cane is passed through this crusher at the rate of 25 tons per hour. The juice, as it runs from the rollers, passes into a large tank, from which it is pumped into the defecating room. Here it is run into six defecating pans, capable of holding three tons of juice each. In these are coils of copper tubing, through which steam is passed to heat the juice. To the lukewarm juice is



HEREFORD CATHEDRAL. (Drawn by the late S. READ.)

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then added milk of lime, until slightly alkaline, in order to neutralize the acids, which are always contained in it,and to coagulate the albuminous matter present. It is then heated as rapidly as possible to the boiling point, and the steam is shut off when the thick scum, which rises to the surface, begins to swell and break. After a few minutes the juice is skimmed, and it is again heated, this time to a quiet ebullition, and again skimmed. This is repeated a few times, and the result is a very clear juice, almost free from sediment. From the defecating room the juice, containing 84 parts of water and 16 parts of sugar, passes to the evaporating pans, where it is boiled down to 54 parts of water and 46 parts of sugar, when it is called "semi-sirup." This passes into a small vacuum pan, and from there into the bone-black filters. These are six in number, and are each cylindrical in shape, four feet in diameter and twenty feet high. Here the sirup is decolorized and deodorized, after which it is pumped into the large vacuum pan. This is ovoid in shape, made of boiler iron, and looks like a huge retort. It is seven feet in diameter, nine feet high, and will hold more than 1,000 gallons. In this the semi-sirup boils at 70° C. under diminished pressure, instead of 110° C. in free air. This is a great advantage, as it is a well-established fact that high heat and much exposure to the air quickens the conversion of saccharose into invert sugar. From the vacuum pan the sirup is put into large iron wagons, which hold about 250 gallons each, and in them is run into the crystallizing room. This room is kept at a temperature of 55° C., and in it the sirup is allowed to stand for several days until it crystallizes. The "melado," as the sirup at this stage is called, is then run into the mixer. This is a long bar with fingers attached, the whole revolving in an iron box. In this the melado is thoroughly mixed and made ready for the last process. From the mixer the melado is run into the centrifugals. These, four in number, are tubular vessels about three feet in length and two feet high, open above and closed below. Each is lined with fine copper sieve, a space of perhaps two or three inches intervening between the sieve and the outer wall of the centrifugal. The centrifugals are set in motion at the rate of 2,000 revolutions per minute, and the melado is run into them, falling upon a revolving disk in the center. From this the melado is thrown with great force against the side of the vessel, striking upon the copper sieve, which is also in rapid revolution. The force of the projection throws the sirup through the sieve, while the crystallized sugar remains behind, whitening the longer it "spins," as the process is called. It is generally allowed to spin about fifteen minutes, after which the raw sugar is taken out and put into barrels, and the process is completed. Each centrifugal is capable of spinning 200 lb. of sugar in those fifteen minutes. Besides these details, the process has, of course, its secrets, which are also kept as such.

From the above named factory I obtained a sample of sugar, of which I made an analysis, which shortly will be explained. In appearance the sugar looks very much like the common raw sugar of commerce. But in odor and taste it differs somewhat, as it has retained some of that peculiar sorghum flavor, which is not disagreeable, and in which place in common raw sugar is found a taste and smell of burnt sugar.

In my analysis of the sorghum sugar I found the following constituents:

Saccharose	92·00 per cent.
Glucose	4·50 per cent.
Moisture	1·50 per cent.
Ash	1·10 per cent.
Impurities	0·90 per cent.
	100·00

The amount of saccharose was acertained by the use of the Wilde polariscope, which as an average showed 92°. With the same instrument I examined samples of different sugars with the following results (the strength of the solutions was 10 grammes of sugar and water sufficient to make 100 c. c.):

White rock candy polarized	100°
Yellow rock candy polarized	98°
Best granulated sugar polarized	99°
White A sugar polarized	94°
Common raw sugar polarized	84°
Sorghum sugar (4 experiments)	90°, 92°, 93°, 92°

Common raw sugar was also subjected to analysis for comparison:

Saccharose	84·00 per cent.
Glucose	11·80 per cent.
Moisture	2·50 per cent.
Ash	0·70 per cent.
Impurities	1·00 per cent.
	100·00

The moisture and ash of granulated sugar were also ascertained, and found to be respectively 0·55 and 0·44 per cent. This shows in reference to the moisture, that the more glucose contained in the sugar, the more moisture is absorbed. As to the sorghum sugar the comparison is very satisfactory, as it contains eight per cent. more saccharose than the common raw sugar, and only two per cent. less than the A sugar, which has gone through a refining process. This very satisfactory result is due to the improved machinery of which the vacuum pan and the centrifugals are the most important, and without which the idea of sugar making, from sorghum, at the present sugar prices, might be given up as almost hopeless. But as it is, sorghum sugar can compete with other sugars, both in price and quality.—*Am. Jour. Pharm.*

HEREFORD CATHEDRAL.

A VIEW of this cathedral, by the late Mr. S. Read, is presented for our extra supplement. It has an edifice which, besides containing some important Norman building in the piers of the nave, choir, and south transept, is rich in the Early-English and in the Geometrical Gothic style of architecture. The Early-English Lady Chapel is an excellent example of that period; but the north transept, showing the transition to Decorated Gothic, is still more remarkable. Extensive "restorations" have been effected, not always with the best judgment, as in Wyatt's work from 1788 to 1797; but of late years, under the direction of Sir Gilbert Scott, much has been done to remedy the mischief previously suffered. The Bishopric of Hereford is one of the most ancient in England, dating probably from the sixth century, or certainly from the seventh; it is now held by the Right Rev. James Atlay, D.D., who was consecrated in 1868, and who is the ninety-fifth in succession.—*Illustrated London News.*

THE VIBRATION OF STEAM VESSELS.*

By MR. OTTO SCHLICK.

ALL steamers, without exception, shake to a more or less degree when the engines are in motion. This phenomenon is usually considered as so natural that in most cases little or no attention is paid to it; and when ships with comparatively powerful engines show an unusually strong vibration, it is either looked upon as quite natural, or the phenomenon is simply accounted for by saying that the ship is of too weak construction. It will not have escaped the observation of those who have paid much attention to these vibrations that not uncommonly weakly-constructed ships with powerful engines exhibit only a small amount of shaking, and, conversely, that comparatively strongly-built ships are subjected to exceptionally violent vibration. The author has had occasion to make observations with respect to this matter, and has arrived at the conclusion that a comparatively large engine power, combined with light construction, is by no means necessarily accompanied with violent vibrations, and that under these conditions a quiet working elasticity, which will bring the masses back to their position of equilibrium. Should this force be small (which would represent the case of a weakly constructed ship) and the mass great, the vibrations would be of considerable duration, the extremities would swing in slow measure; should, on the other hand, the elasticity be great and the mass small, then the vibrations would follow each other in quick time. There exists still, it is true, a moment which has an influence on the periods of vibration, but which may be here neglected, that is, the resistance of the water as opposed to these vibrations. A ship of which the engine is working at a regular number of revolutions will always be subjected to certain forces, similarly to those here described, which will appear at regular intervals, and fall together with the revolutions of the engine, and alter their direction with it. The most important of these forces produced by the working of the engine are the following:

The forward thrust.
The turning couple of the engine.
The sideward pressure of the propeller.
The pressure of the reciprocating masses.

SUGGESTIONS IN DECORATIVE ART.--TIN JUG IN THE NATIONAL MUSEUM AT MUNICH.
—*From Workshop.*

very often occurs. Other moments, most probably, come here into consideration, which have a marked influence on the vibrations. A ship's hull is, like all other bodies, subjected to the laws of elasticity. When, therefore, a quietly swimming ship's hull is suddenly exposed to the action of a force, which we will assume to be a force acting at right angles to the longitudinal axis of the ship, it will bend through to some extent, although this bending is of an extremely small magnitude. Let us now suppose that the force suddenly ceases to act; the ship will then not only be compelled to return to its original form, but its extremities will, in virtue of the inertia of the mass, overreach to a certain point the position of equilibrium, or the original position, and from this point motion again ensues in the reverse direction, and so forth.

We thus see that it is with regular vibrations we have here to deal. The time which such a vibration occupies is dependent on the dimensions of the swinging masses (in this case on the masses of the ship's extremities), and on the extent of the force in question, in this case that caused by

The pressure of the rotating masses, when the position of their center of gravity is out of the middle.

All these forces either alter their intensity or they spring round to an opposite direction during the time occupied by the engine in performing one revolution. As far as our experience extends, the three last-mentioned forces are those which produce the shaking and vibration in a ship. As their direction is at right angles to the longitudinal axis, and a ship offers least resistance to the bending of this axis (namely, to bending in a vertical plane), the vibrations will be most readily produced in this direction, their amplitude will be greatest, and their period of oscillation will also be longest. Now that it has been made clear that in dealing with the vibrations of a ship we have only to consider regular oscillations, the conditions which favor or diminish these vibrations can be at once distinguished. The vibrations will be greatest when the time occupied by a revolution of the engine corresponds with the period of oscillation of the vibrations, as the oscillating masses receive a fresh vibration-producing impulse at the commencement of each new vibration, and the vibrations must necessarily assume a continually increasing amplitude, should obstacles of various

* Paper read before the Institution of Naval Architects, London, on April 3, 1884.

natures not exist, and should the elasticity of the ship's hull be perfect. The phenomenon bears considerable resemblance to the oscillations of a clock pendulum, which also receives the necessary additional power to sustain its motion through the small impulses it obtains from the clockwork on the completion of each oscillation. It is clearly not absolutely necessary for the production of strong vibrations that the period of vibration and the revolutions of the engines referred to a certain unit of time be the same; on the contrary, it is sufficient should one of these numbers be a multiple of the other, such as two, three, or four times greater. The question is whether this hypothesis is confirmed by practice. We think this question can certainly be answered in the affirmative. When a steam vessel lying at rest (we will say a screw steamer) is set in motion, one usually remarks at first little or no shaking. As the revolutions of the engines gradually increase, one notices, in many cases, that suddenly, as if with a shock, clearly perceptible shaking or vibrations set up, which extend themselves over the entire length of the ship, those at the extremities being most perceptible, and sometimes producing a disagreeable effect.

If the phenomenon arises in the way we have described, it is an indisputable fact that we have then the case before us where the number of revolutions of the engine falls either quite or nearly together with the period of vibration of the ship. In ships which in general exhibit an exceptionally strong vibration, it may always be observed that the shaking suddenly arises on attaining a certain number of revolutions of the engine—a phenomenon which can be explained as above. It may be here observed that, although in most cases the period of vibration of an iron screw vessel be smaller than the time of revolution of the engine working at full power, yet usually the difference does not appear to be very great; we assume that a vibration in reference to the bending of the longitudinal axis be only here taken into consideration. These circumstances point to the fact that by many ships an irregular shaking is observable, which must be distinguished from the regular vibrations of which we are here speaking; and that regular vibrations only arise by an exceptional exertion of the engine. It may, on the contrary, be observed very often in screw vessels which exhibit a very quiet motion when going full speed ahead that, when the engines are working astern, they are exposed to very strong and distinct shaking, which manifests itself in regular vibrations. It may thus be explained. When working astern, the engines of screw vessels usually attain a higher number of revolutions than when going ahead, whereby the coincidence of the time occupied by a revolution with the period of vibration is rendered possible. Certainly other conditions enter into consideration which tend to increase the intensity of the vibrations; for example, the water thrown against the ship's hull by the screw has certainly a great influence; the cause of these appearances may, however, be mainly referred to the synchronism of the revolutions with the period of vibration. A case was observed by the author under particularly interesting circumstances, in which the time occupied by a revolution of the engine was less than the period of vibration of the ship, which may be here shortly described.

The ship in question was a small passenger steamer, 140 feet long, of very sharp form, very strongly built, and provided with a comparatively powerful engine. When the engine attained the usual number of revolutions for full power (89 per minute), strong vibrations suddenly manifested themselves. They were so violent that the ship was reluctantly made use of by the public, and it was consequently rendered necessary to take steps to alter this defect. After protracted irresolution, it was decided to replace the three-bladed screw by a four-bladed one, and to reduce the diameter, laboring under the false impression that the vibrations were caused by the relatively large propeller. The result was more favorable, although for other reasons than those assumed, as the steamer exhibited at full speed, with the new screw, only very feeble shaking, but the engine made from five to six revolutions more per minute, or in other words, the time of a revolution of the engine was no longer the same as the period of vibration of the ship. The assertion that the vibrations were caused by their coincidence with the revolutions was confirmed by this phenomenon; another circumstance, however, tended to show the correctness of this theory, namely, before the engine had attained command and reached its full number of revolutions on the departure of the ship, violent vibrations such as formerly existed were observed for a few moments; these were indisputably caused through the period of the revolutions, which, during the starting, became shorter and shorter, agreeing for a moment with that of the vibrations of the ship. As the number of revolutions continually increased, this concurrence and the consequent vibrations only took place momentarily. Similar observations have been made on modern torpedo boats, which are provided with exceptionally quick going engines. The vibrations caused a much greater shaking when the number of revolutions was about two-thirds of that which the engine gave out at full power.

It would be interesting to learn, should the case have been observed, whether the shaking produced by two different numbers of revolutions, one double that of the other, reaches in that case a maximum; according to the hypothesis assumed, this should be the case; when, for example, the shaking is most violent at 200 revolutions, it should attain another maximum with 400 revolutions. In the case of paddle steamers, and especially that of lightly-built river boats, a similar phenomenon may in every case be observed. The time occupied by a revolution of a paddle engine is so considerably longer that it is out of the question to suppose it could agree with the period of vibration of the ship; whereas, the striking of the floats under certain conditions appears to follow at such intervals as might cause a vibration of the ship's hull, and it may be thus explained that paddle boats suddenly exhibit violent shaking for a short period after the engines have been started, but have not attained full command of the vessel. These appearances may also be usually observed if the engines be brought from full to half power. The practical bearing of our considerations involves an answer to the question. What may be done in order to avoid or to diminish violent vibration? We assume that we have only to occupy our attention with regular vibrations which produce a reciprocating deformation of the longitudinal axis along its whole length. The longitudinal axis of the ship is represented in its position of equilibrium by a straight line. But as the engine is usually placed in the neighborhood of the middle, the vertical reciprocating forces produced by the action of the engine will also act there, and cause a bending through of the ship, so that its axis will alternately assume curved forms. This is sometimes perceptible with the unassisted eye if, as above described, the period of oscillation agrees with the revolutions of the engine. If short sighting laths be put up at both ends and in the middle of the ship, which, when she is at rest, lie in one straight line, the vibrations of the ship may, by their aid in very many instances, be clearly observed when under steam.

In addition to the above mentioned forces, which produce a vertical bending action in the middle of the ship, there also exist in screw vessels some others acting at the ends, produced either by an eccentric position of the center of gravity of the screw or by the unsteady, one-sided pressure of the propeller itself. The most natural means of avoiding the vibrations would obviously be to remove the causes which produce them. This is, however, impossible. A one-sided position of the center of gravity of the propeller can be avoided; it will never, however, be possible to eliminate the forces caused by the reciprocations of the engine, even if the engine should be well counterbalanced. The only other case remaining consists in preventing the coincidence of the period of vibration with the revolutions. Should one take steps in this direction, then it is easier to alter the number of revolutions of the engine, which may be best done in the case of screw engines by the substitution of a propeller with altered pitch. Before, however, deciding on the pitch of the new propeller, one must be quite clear as to whether it be more advantageous to increase or diminish the number of revolutions. The latter course will generally attain the desired result, and it will only be correct to reduce the pitch of the screw and thereby increase the number of revolutions in those cases in which the conviction has been gained, through forcing the engines, that an increase of the revolutions does not increase, but, on the contrary, diminishes the vibrations. It is thus clear that the employment of a new form of screw, although the same may be quite irrational, often gives a favorable result as regards the diminution of vibration. The shipowner only then decides on such an alteration when the vibrations are very considerable, and as the new screw will in almost every case make a difference in the number of revolutions, the result, with regard to vibration, must be a favorable one.

It is to be observed that the masses of the ship and its cargo have an influence on the vibrations. Should the cargo be placed in the middle and at the extremities, the period of oscillation, when thus stowed, will become slower; should, however, the mass of the cargo be more concentrated in the nodal points, then the vibrations will follow in quicker time. We are in this way placed in possession of a means by which a reduction of the vibrations may be attained. In practice this is only of little or no value, as, in consequence of the hurried manner in which loading of a ship must take place, those in charge are not in a position to pay sufficient attention to the stowing. A single experiment, with an alteration in the way of stowage, taking into consideration the above-mentioned points, is to be recommended in all cases in which a steamer vibrates strongly, as a conclusion may be drawn with greater certainty whether an increase or diminution of the revolutions of the engine will be of advantage in reducing the vibrations. Another moment which has an influence on the period of vibration consists of the force in virtue of elasticity with which the ship will return to its normal form after having been deflected. The extent of this force is dependent on the greater or less strength of construction of the ship; and usually there is only then an alteration in this direction conceivable when an endeavor is made to increase the stiffness or elasticity of the construction by means of appropriate strengthening. Should the revolutions of the engine fall in with the period of vibration of the ship, one could diminish the vibrations by appropriate strengthening of the longitudinal axis of the ship, and, as a consequence, the period of vibration and the time of revolution will become different. The result of pursuing such a course is not generally a very favorable one; this may be accounted for by the fact that the new strengthening pieces bear too small a proportion to the whole structure. Should strengthening pieces be applied to a ship of which the period of vibration is somewhat longer than the time of revolution, then the peculiar case is conceivable in which the vibrations of a ship may be increased by additional strengthening. A signal example of this case is unknown to the author; yet the correctness of the assertion can scarcely be disputed.

There is yet another simple way of reducing the vibrations of screw vessels, which, in many cases, is attended with good results. We have already mentioned that in addition to those forces produced in the middle by the engines, there also exist those caused by the one-sided position of the center of gravity of the screw, which may cause vibration. Let us assume that these forces act in a contrary direction to those producing vibration in the middle, and let us assume also that, for example, in the same instant that the masses of the engine produce the greatest pressure downward, the propeller develops the greatest upward pressure, then the working of the two forces assists each other, and the resulting vibration will be very violent. Should, however, the two forces act simultaneously in the same direction they will then tend to neutralize each other, and the vibrations will have the least amplitude. As it may be assumed that in every case the center of gravity of the screw lies more or less out of the middle, or that other inequalities exist with regard to area and pitch of the blades, then a diminution of the vibrations may be often attained by turning the screw in relation to the cranks of the engine. One may proceed best as follows: After having carefully considered the vibrations, uncouple the screw shafting and reconnect it, so that the screw has been turned round 180° with regard to the cranks. This will be always possible when the number of coupling bolts is an even number, and when the holes are exactly pitched. On trial under steam it will be found that the vibrations are either greater, less, or unaltered. Through a further shifting of the screw through a less angle, it will, with a little thought, be easy to discover the position of the screw in relation to the cranks by which the vibrations are least. These trials, which can nearly always be performed with ease, give in most cases a good result, naturally with the exception of those in which the screw has the most favorable position to start with. Care should always be taken with new engines that the holes to receive the coupling bolts be exactly pitched, so that it may be possible to connect the shafts together with every combination of bolt-holes. This necessitates very careful workmanship. It is further to be recommended that in one pair of couplings a different number of bolts be used to facilitate the turning of the screw through a very small angle in relation to the cranks. If, for example, one coupling has six bolts, the smallest angle through which the shaft can be turned is 60°; should another pair of couplings have five bolts, then a turning through 72° is possible; should both pair of couplings be shifted, the screw may be turned through $72-60=12°$. The screw can thus be set in at least thirty different positions with regard to the cranks.

All that has been yet said has had reference to a vertical bending of the longitudinal axis of the ship. These oscillations seldom appear alone, but are usually accompanied by others, which produce a torsional strain. To do this, sufficient causes always exist. The variations of the moments communicated to the shaft by the engine, the sideward pressure of the screw produced by a false position of the center of gravity, the reaction of the reciprocating masses of the engines in twin screw vessels, etc.—all these factors are disposed to produce torsional oscillations. Besides these vibrations, others occur in a ship which according to their nature work only on a particular part of the ship. These may be called local vibrations. The most important of them will be here shortly considered, namely, the vibrations in the ship's bottom, and those in the neighborhood of the stern-post in screw vessels. Oscillations of the bottom can occur through the influence of the reciprocating masses of the engine being transformed into an up-and-down motion. These will only be taken up by the middle and flat part of the bottom. The phenomenon bears a certain resemblance to the vibrations of a drumhead. This motion of the ship's bottom will, however, only exceptionally make itself evident as true vibrations, as the revolutions are, according to experience, far removed from the period of these oscillations. It is only in flat-built boats with quick running engines, such as is the case in river boats, that the phenomenon has been observed. The motions of the engine foundation, which are so often observed, are not to be considered as vibrations in this sense; on the contrary, one has here only to consider the yielding of a too weak structure which is not capable of withstanding the pressure caused by the reciprocating masses of the engine. The vibrations of the bottom are best avoided by means of strong transverse stiffening of the ship's bottom with strong webframes. The vibration of the stern-post or dead wood (if one may apply this term to the sharp part of the stern of an iron ship) is an appearance which is often observable in screw vessels. The ship's hull can only afford a small resistance to the horizontal force which is called into existence by the eccentricity of the center of gravity of the screw causing a sideward pressure to be exerted on the boss of the stern-post, through which the shaft works. This is especially the case in ships of fine form, in which the breadth of this part is very small, and where a small force would suffice to produce a deformation, in the under ends of the frames, from one side to the other. Further, the angle-iron of the frames cannot, as a rule, be carried down to the keel in its full dimensions, and therefore the strength of the whole construction of this part of the ship becomes dependent on the outer plating. Should it happen that the period of vibration and the revolutions fall together, then the vibrations will, under certain conditions, be so violent that they may earnestly endanger the strength of the riveted joints. To the modern large ocean steamers, with their exceptionally powerful engines, the loosening of the rivets in the stern-post and dead wood has become, as is well known, an ever-existing calamity.

The author here wishes to express the opinion that more attention should be paid to the vibrations of steamers than has hitherto been done, as they must have a great influence on the strength of the ships; this is amply confirmed by practice. The strains produced by the vibrations are, it is true, not so great that through these alone the strength of the structure would be affected to a doubtful extent. One must call to mind that usually, when in the position of equilibrium, or, in other words, when the ship is at rest, there already exists a considerable strain in the top and bottom parts. Now, it is known that when the ship works in a seaway, these strains approach nearly to their admissible limit, and a further increase of them through vibrations must be very dangerous. It is also easy to be understood that the continual alteration of the direction of the strains through vibration loosens the riveting sooner than a stronger though more constant tensile strain would do. Special instances could be here mentioned which evince that the frequently observed giving way of the riveting in large steamers is, in most cases, to be attributed to the violent vibration, rather than to insufficient strength. In order to make more exact investigations regarding vibrations, we require, before all things, an appropriate instrument to measure their amplitude and direction. Until the present time no such apparatus, it would appear, has been constructed which can make any claims to exactness, so that up to this time we have been without the means of proving, with certainty, whether the vibrations of a steamer are under certain conditions greater or less, so that one has been almost entirely dependent on the opinion of the observer.

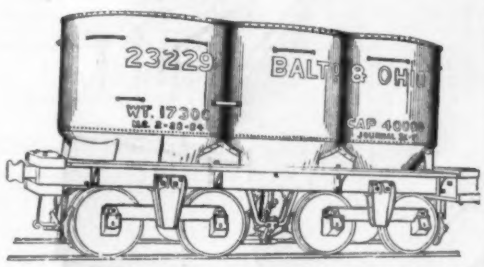
Under these conditions it would, perhaps, not be without interest if a short description of an apparatus be given which the author constructed, after many unsuccessful attempts, to measure the amplitude of oscillations, and which gives to some extent useful results. All apparatus which can be constructed to measure vibrations must generally depend on the principle that, if a heavy weight be suspended in the interior of the ship, so as not to be rigidly fixed to it, but connected to it through an elastic medium, it need not in consequence follow the vibratory motion of the hull. The first thought which enters one's mind is to suspend a weight by means of India-rubber strings. This arrangement nearly always fails, however, to perform its functions, as the weight very soon comes into a state of vibration, caused by the insufficient elasticity of the India-rubber cords. The suspension must, therefore, be performed in another manner; that to be described has proved itself the only one that can be made use of. A spherical or other appropriately formed piece of cast iron, weighing from 25 lb. to 40 lb., is fixed to the thinner end of a wooden rod, for which purpose a strong boat-hook, from 12 to 15 feet long, adapts itself well. The thickness of the rod must be such that, when fixed at one end, it can just carry the weight in a horizontal position without breaking. The other (thicker) end of the rod is fixed to an appropriate part of the ship in such a manner that the thinner end takes up a nearly horizontal position parallel to the longitudinal axis of the ship. Nearly the whole length of the rod must therefore swing freely, whereby a considerable deflection will take place. If the weight receives a push, it will be set in slow vibration, and if the apparatus act well, the weight should not make more than twenty-five to thirty-five double oscillations in the minute. The weight thus suspended will in most cases not participate in the vibratory motions of the ship, but will remain quite steady when the engines are working, or will only be set in slow oscillation. Should the free end of the sphere be provided with a pencil, and a surface covered with paper be brought against it, the amplitude of the oscillations will be marked on the paper. One sees from the figures which are drawn on the paper in which direction the vibrations take place. If the paper which is placed opposite the pencil be constantly moved forward by means of clockwork (an experiment the author has unfortunately not had the opportunity of making), a diagram will probably be drawn which would give us more exact information with regard to the character of the vibrations.

For those who may intend making a similar experiment,

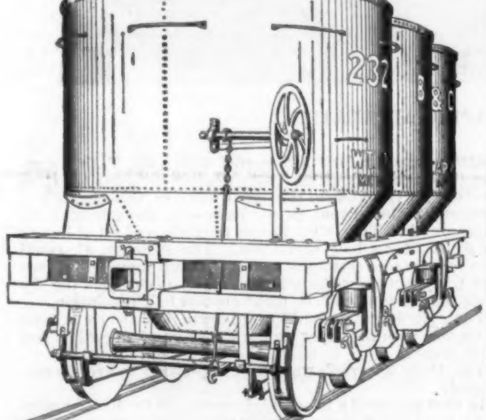
a few practical hints may be here given. First it may be remarked that the pencil must be fitted in a holder in such a way that it may be always pressed against the surface by means of a spiral spring; the spiral spring must be comparatively long, so that a light pressure on the pencil produces a motion of a few inches. It is, further, not easy to prevent the weight, and naturally the rod, from participating in the vibrations, as the vibrations of the rod form certain nodal points similar to those of a violin string which has been caused to vibrate. This defect can usually be removed by altering the length of the rod. In order to investigate perfectly the vibrations of a certain part of a ship's hull, it would naturally be necessary to arrange three different apparatus in such a way that they should indicate the vibrations in different planes. The author has only used this apparatus to discover the amplitude and approximate direction of the oscillations, as the entire apparatus was constructed in a very primitive manner. The method is certainly, however, capable of further improvement, and is perhaps capable of procuring for us information regarding many phenomena connected with vibrations which have not yet been explained. In any case the method places us in possession of a practical means of deciding whether the vibrations, after the completion of an alteration in the propeller or in one of the other factors which produce vibration, have been increased or diminished.

COAL HOPPER CARS.

WE give herewith perspective views showing side and end



COAL HOPPER CAR.—BALTIMORE AND OHIO RAILROAD.



COAL HOPPER CAR.—BALTIMORE AND OHIO RAILROAD.

of the iron coal hopper car of the Baltimore & Ohio Railroad.

STEAM DERRICK CAR.

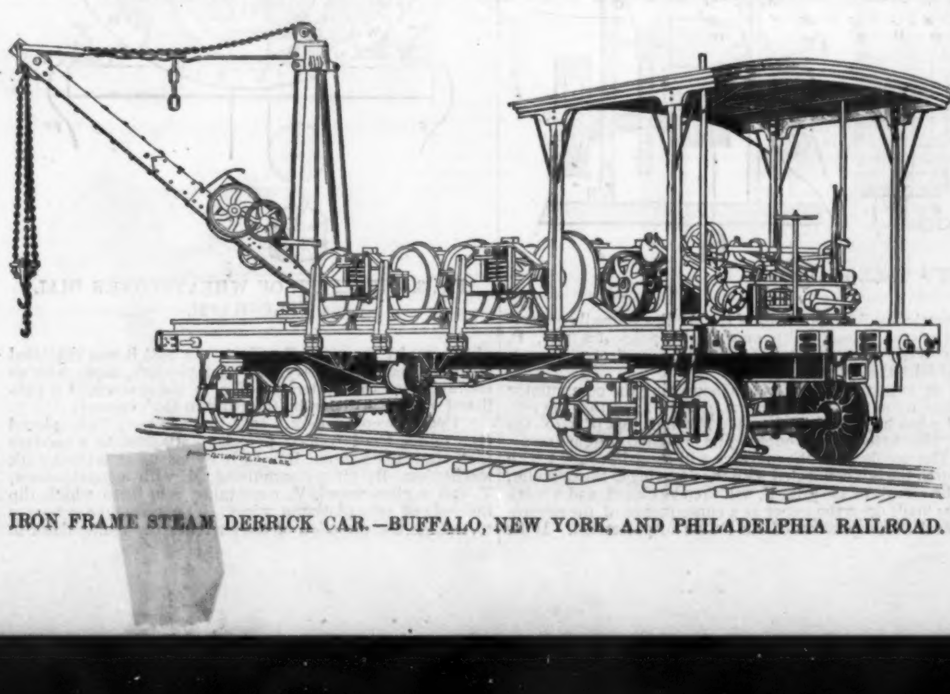
THE drawings illustrate the iron frame steam derrick car of the Buffalo, New York & Philadelphia Railroad, designed and constructed by Mr. Allen Vail, the Superintendent of Motive Power and Machinery. Its leading peculiarity as compared with other cars of this class consists in the material of the frame, which is iron. With this material a maximum of strength and rigidity is obtained in the foundation without excess of weight, and at the same time making the attachment of rods and braces to sustain the superstructure easy and secure.

The car is of the gondola pattern, with a crane at one end, and a double cylinder hoisting engine under the roof of an open cab at the other, the intervening space being occupied by a pair of spare trucks. The floor is composed of I-beams covered with planks 2 inches thick. The upper brace-rods are of 1¼, and the lower ones of 1½ inch iron. The engine cylinders are 6½ × 7 inch with rotary valves worked by link motion, and can handle any load that the crane will support. The chain passes down through the mast, thence to the engine drum.

To provide against emergencies, the crane is fitted with ordinary hand-gear, which is also convenient when the flexible steam connection with the boiler for the supply of the engine is disconnected. Gripping devices at the forward or derrick end of the car are provided in case it becomes necessary to fasten it to the track, and screws with capstan heads take the weight off the springs when the derrick is in use.

This much with respect to the general design. The subordinate details have apparently been worked out with equal care, and with a view to effective and economical service.

The weight of the car is 30 tons; its length from face to face of drawheads is 33 feet ½ inch. The trucks have 33-inch wheels, and both hand and air brakes are provided. The car-builder in examining the cuts will observe many details to which it is not necessary to make special allusion in the description.—*Nat. Car-Builder.*

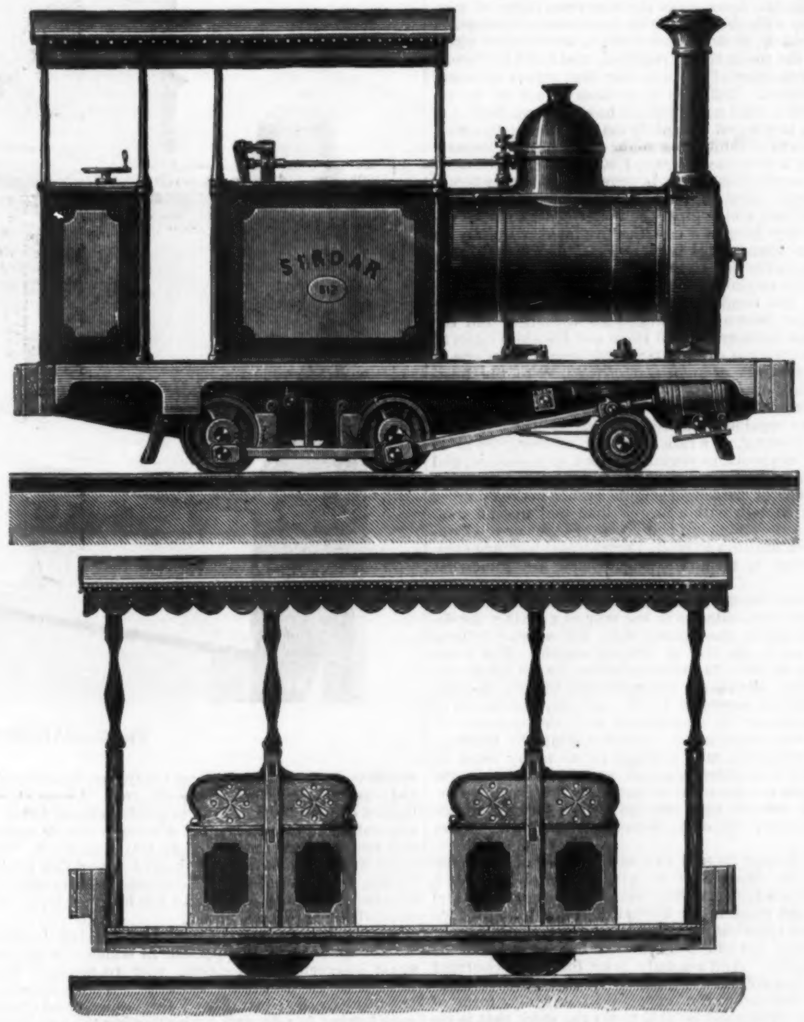


IRON FRAME STEAM DERRICK CAR.—BUFFALO, NEW YORK, AND PHILADELPHIA RAILROAD.

PORTABLE RAILWAY, CAR, AND LOCOMOTIVE.

AMONG the exhibits at the recent Calcutta Exhibition was a portable railway constructed and shown by Mr. W. G. Bagnall, of the Castle Engine Works, Stafford, together with a complete rolling stock, part of which we illustrate. The line was laid around the lake, and was 2 ft. gauge. It consisted of 16 lb. steel rails in 10 ft. lengths, secured to channel sleepers by means of clips, which fitted up close to the web of the rail. The inside clips were riveted with two ½ in. rivets, and the outside clips bolted with two ½ in. bolts. By this arrangement the whole can go away in parts to save freight, and the cost of bolting on arrival does not exceed 5*l*. per mile, and when done the railway is equivalent to a portable riveted railway, and extra sleepers can be fixed at any point where the ground is not sound. There are three sleepers of channel iron 2 ft. 9. in. long by 4 in. wide to each 10 ft. length, and a joint sleeper 5 in. wide, so that no fish-plates are required. Mr. Bagnall is of opinion that the sleepers should project beyond the rails, the extra length amply justifying the extra cost. The weight per mile of the railway is about 38 to 40 tons, and the value about 400*l*. per mile.

The exhibit included eight wagons of various descriptions, bogie and otherwise, suitable for carrying sugar canes and other colonial produce, and also three passenger cars and a locomotive, which form the subjects of our illustrations. The car in the engraving is made of pitch pine and will carry twelve persons. The locomotive has cylinders 5 in. in diameter by 12 in. stroke; the four coupled wheels are of solid steel, 15 in. in diameter, with a leading pair of bogie wheels 12 in. in diameter. The rigid wheel base, from the trailing axle to the pin of the bogie, is 8 ft. 7 in., and the flexible wheel base is 7 ft. This engine will pass round curves of 35 ft. radius. The weight on the bogie wheel is adjustable, and the total weight of the engine in working order is 4¼ tons. The tank is placed behind the foot plate, and the boiler fed by an injector and by a triple valve pump worked by an eccentric. The brake locks the four coupled wheels. The firebox, which is constructed for burning wood, is of copper, and the tubes of brass, the total heating surface being 90 square feet, of which 21 are in the firebox and 69 in the tubes. The grate area is 2·04 square feet, and the working pressure 150 lb. There is an awning over the driver, with a spark arrester in the chimney and an ashpan to hold water. The engine is capable, in ordinary work, of hauling loads of 40 to 50 tons on a fairly level road.—*Engineering.*



LOCOMOTIVE AND CAR FOR PORTABLE RAILWAY.

HIGH SPEED ON AMERICAN RAILWAYS.

IT is generally conceded that there is some pretty fast running on English railways, even after making allowance for exaggerated reports. The average speed of the "Flying Dutchman" trains between London and Bristol, on the Great Western, as stated upon good authority, is 45·6 miles an hour, including two very short stops; and that of the "Flying Scotchman" trains between London and York, on the Great Northern, 48·2 miles an hour, including one stop of six minutes. This last, however, is exceptional. The fair running average, including stops, of English express trains making long runs is 45 miles an hour. There is, of course, a remunerative demand for this rate of speed, or the trains would not be run. In the United States, however, it is only within a recent period that any very considerable portion of the business community has asked for any greater maximum speed between our principal cities than 40 miles an hour. It may be said, indeed, that an average rate of 35 miles for what are called through trains has hitherto proved quite satisfactory from a business standpoint. But with the growth of our chief cities in population and commercial importance has come a demand for faster trains between these points, and railway companies have been called upon to provide engines adequate for the service. The geographical location of our large cities is such that the transit between the principal ones on the Atlantic coast has usually been made in a single

night without encroaching on the business hours of the day; and so long as there was no pressing need of trains that would make these distances in the morning or evening, the railway management aimed only to provide transportation at moderate rates of speed, as compared with the reported fast running on English roads. With respect to the longer distances, the time between New York and Chicago has of late been reduced somewhat, but in former years it practically amounted to a day and a half, and for trains leaving either city in the evening, an increase of speed so as to cut off one night was of no very great advantage either to the passengers or the railway companies.

Under these circumstances, sleeping and drawing room cars with all the luxurious concomitants of modern railway travel were introduced, the result of which was an increase in the weight of trains very much exceeding the average on European roads. Yet it is not difficult to run these trains at a rate of 35 miles an hour, with the American type of passenger engines, with their elastic arrangement of springs, 17 × 24 inch cylinders, 66 or 68 inch drivers, and flexible wheel base. To get the steam that is required, coal must be burned at a rate per square foot of grate surface that makes economy out of the question. But even if economy were of no account, the limit of fuel consumption has been reached, and the coal has to be burned so rapidly that it is impossible with the ordinary form of boiler to supply the requisite amount of steam. For a first-class engine, 1,300 square feet of heating surface is scarcely sufficient to develop 1,000 horse power (which the service requires, at the least), and if the firebox is to be turned into a blowpipe, the boiler can hardly be expected to last very long, nor can the fire lie very quietly on the grate. The tremendous back pressure necessary to produce the draught for this wasteful burning is a very considerable tax on the engine.

This being the condition of things with respect to the shorter distances between our large seaboard cities, and the longer distances between each of these and the chief cities of the West, any increase of speed in the transit from one to another, in order to be of any great advantage to the business community, must average as high as 55 or 60 miles an hour. But when our locomotive builders are called upon to furnish engines capable of hauling trains as heavy as those that are now running, at a rate of speed as low even as 45 miles an hour, the problem begins to look a little serious, and at 50 and 55 miles an hour it becomes formidable. Not that the standard type of passenger engine cannot make 60 miles an hour easily enough with a proper load and upon a good track, but when the trains are composed of eight or ten Pullman sleepers, in addition to mail, express, and baggage cars, the limits of what is termed a proper load are somewhat exceeded.

After analyzing the complaints of various master mechanics, setting forth the obstacles in the way of meeting the demand for high speeds, the trouble does not appear to be in the side rods nor in the size of driving wheels. The horse power capacity of 18 × 24 cylinders seems to be ample for doing the work. Reversing arrangements, brakes, the carrying of the needed supply of water, fuel, etc., are things of inferior consequence in comparison with the question of steam supply for the cylinders. After making the boiler as large as is practicable, and putting in as many tubes as safety will permit in order to secure a good circulation, the master mechanic is compelled to thrust his firebox down between a pair of wheels that run on rails 4 feet 8½ inches apart. Right here is the obstacle to high speed with heavy loads.

To sum up, it must be said that the designer of a locomotive that shall be capable of an average speed of a mile a minute under the existing conditions of passenger traffic and of road bed and track in the United States, is brought face to face with the question of a radically new construction of locomotive boiler, the old construction having reached its limit of usefulness. And not only is he forced to confront this question, but still another one of equal or greater magnitude which lies behind it, viz., Will any new form of boiler that can be devised be able to do the work that is required of it?—*Nat. Car-Builder.*

HISTORY OF THE ELECTRIC TELEGRAPH.*

IF we admit, as we have shown, that September, 1837, is the true date of Morse's invention, the honor is no longer due him of having been the first to apply the electro-magnet to telegraphy.

We have already seen that Cooke, in 1836, employed the electro-magnet in his call, for unlocking the movement of a bell. The same year, along toward March, he devised a telegraph with synchronal dial that recalled in a certain measure the Ronalds telegraph. As in this latter, two disks that carried the necessary letters, figures, and signs moved synchronously under the action of two identical clocks, and the letters passed successively in front of an aperture in a screen. Near each train of clockwork there was an electro-magnet, whose armature, pulled back by the action of a spring,

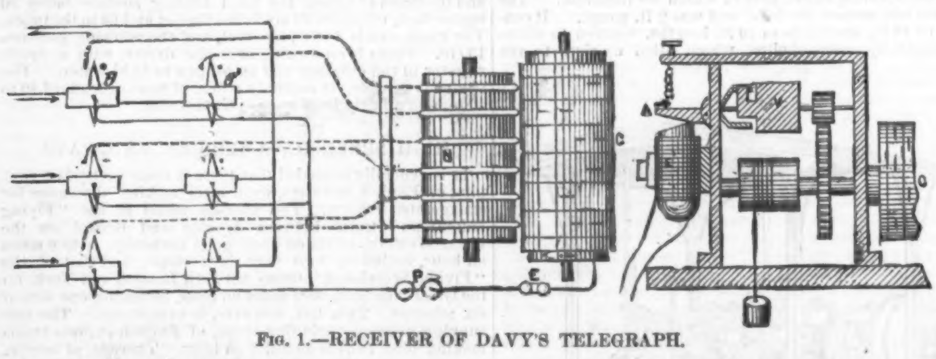


FIG. 1.—RECEIVER OF DAVY'S TELEGRAPH.

stopped the motion. The two electros were in the same two-wire circuit, which included in addition, at the transmitting station, a pile and a mercurial contact. When the circuit was open, the electro-magnets threw the two movements into gear, and two like letters came before the apertures. The circuit, once closed, the letters passed successively in front of the aperture; and, when the sender perceived the one that he wished to transmit, he interrupted the current and thus stopped the clockwork for a few instants, and afterward set it in motion again until the following letter presented itself, and so on.

* Continued from page 6975.

In order to secure greater precision in the stoppages, Cooke soon established for the transmitter as many contacts as there were letters and signs, and provided the dial with spirally arranged pins (one for each letter), by means of which the current was interrupted precisely at the moment that the letter corresponding to the contact that was pressed upon was passing in front of the aperture.

After a few other improvements Cooke devised an arrangement by which he regulated directly, through the emissions of the current, the travel of a needle, which, in this new apparatus, moved in front of a dial that carried the letters. The running of the clock was regulated by a pendulum and an anchor escapement. But this pendulum, whose bob carried two wire armatures, oscillated between two electro-

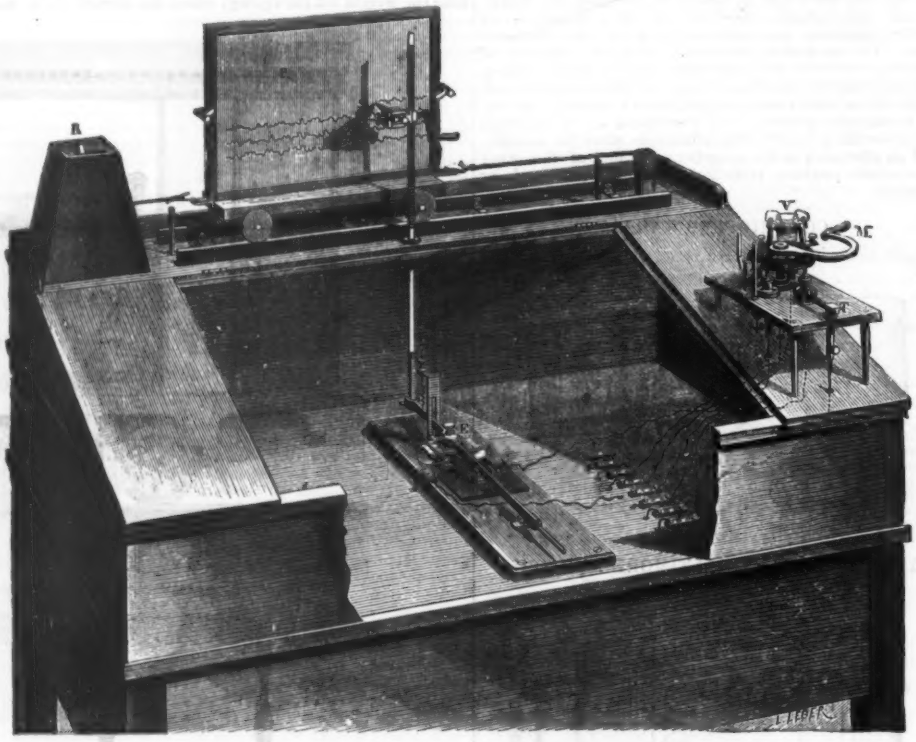


FIG. 2.—JACOBI'S TELEGRAPHIC APPARATUS.

magnets, and its swinging was controlled by successive emissions and interruptions of the current. A camwheel, acting upon a contact lever, served to produce these latter. In this apparatus the electro-magnet was but a simple starting-gear, and really played the part of an active member. The apparatus was very complicated, however, and this explains why Cooke, was refused by the Liverpool & Manchester Railway Company, when he asked it to use his telegraph on the incline of the Liverpool tunnel.

On the 4th of July, 1838, Edward Davy took out a patent for an inscribing apparatus in which the electro-magnet again intervened in a special way to produce the foward motion of an inscribing cylinder. The transmitter of this telegraph consisted simply of three mercurial commutators, each having its pile, and each allowing the current to be sent in one direction or the other. It furnished four wires to the line (all of them starting from the commutators), and one return wire. The receiver (Fig. 1) included three pairs of galvanometric dials, each corresponding to one of the commutators of the receiver, and, by this fact, constituting relays.

When one of these latter was acted upon, the needles of the corresponding pair of galvanometers were reflected in one direction or the other according to the direction of the current, but always in a direction opposite one another. As these needles oscillated between two stops, it resulted that if one touched the stop to the right the other touched that to the left, and inversely. The receiver, properly so called, operated under the action of a local pile. It consisted of a metal cylinder, C, covered with paper soaked in a solution of iodide of potassium and chloride of calcium. Against this paper rested six platinum rings carried by a second cylinder, N. These six rings each communicated, as shown by the dotted lines, with one of the six stops to the left of the galvanometric needles. The axes of the needles were all connected, on another band, with one of the poles of a pile, P, whose other pole communicated with an electro-magnet, E, and with the cylinder, C.

Let us suppose that we are maneuvering the commutator that acts upon the galvanometers, g and g', and that the needle of g has been deflected to the left and that of g' to the right. This latter, then, touching an insulated stop, has no action. The needle, g, on the contrary, will come in contact with its stop to the left connected with the first ring of the cylinder, N. The circuit of the pile, P, will then be closed, and a mark will be made upon the paper as a consequence of the electro-chemical decomposition of the iodide of potassium. If the current be sent in an opposite direction, the needle, g', will give the contact, and the mark will be made opposite the second platinum ring.

By acting, then, upon one, two, or three commutators, one, two, or three marks, distributed in different ways between the six spaces corresponding to the six rings, could be produced upon the cylinder in the direction of one of its generatrices. The position or the number of marks upon the same horizontal line served to distinguish the different letters, and for its transmission each letter required, at a maximum, three dashes. The cylinder, C, did not revolve continuously, but moved foward only a certain amount at the moment of transmitting each sign, and it was for such motion that the electro-magnet, E, served. The armature of this electro actuated a fork that geared with a fly, V, thus stopping the wheelwork which tended to cause the cylinder, C, to revolve. At the moment the signal was sent, this electro was traversed by the current, as we have seen, and attracted the armature, A. This latter raised the fork, and set at liberty the fly, V, for a half revolution. The cylinder, C, could then revolve to a certain distance. At the moment the current was open anew the armature rose, disengaged the fly again, and permitted it to make another half revolution.

The cylinder, C, moved foward again, and the rings came in contact with the paper in the direction of a new line free from dashes.

The Davy telegraph was too complicated to ever be employed.

In 1839 appeared a telegraph invented by the Russian physicist Jacobi, and upon which works treating of the history

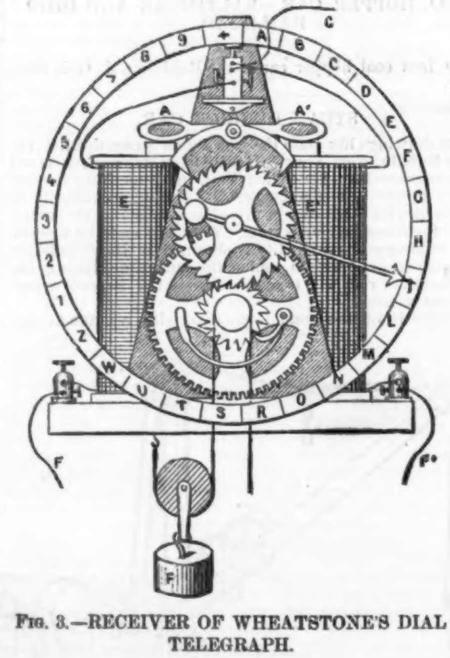


FIG. 3.—RECEIVER OF WHEATSTONE'S DIAL TELEGRAPH.

of telegraphy are generally silent. In 1881 it was exhibited at the Palace of Industry, and we reproduce, along with an engraving of the apparatus (Fig. 2), the account of it published on that occasion by the Russian Government:

"Upon a wooden desk," says the account, "are placed (1) a tablet, P, of framed porcelain attached to a carriage that runs upon small iron rails by means of a clockwork mechanism, R; (2) a commutator, M, with a manipulator, T, and a glass vessel, V, containing acid, into which dip the ends of two platinum wires. The commutator serves to change the direction of the current; the manipulator to

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transmit the dispatches; and the glass vessel to observe the presence of the current through the decomposition of the water, thus taking the place of a galvanoscope.

"A horseshoe electro-magnet, E, arranged in the interior of the desk, is put in communication by a rod, C (that acts as a lever), with the porcelain tablet. A mechanism for adjusting and moving the pencil, S, is attached to the end of the rod that corresponds to the tablet.

"Upon pressing upon the manipulator, a pile current is set up which, through the aid of the electro, starts the pen-

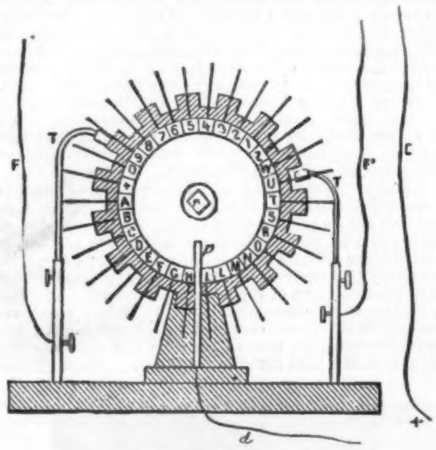
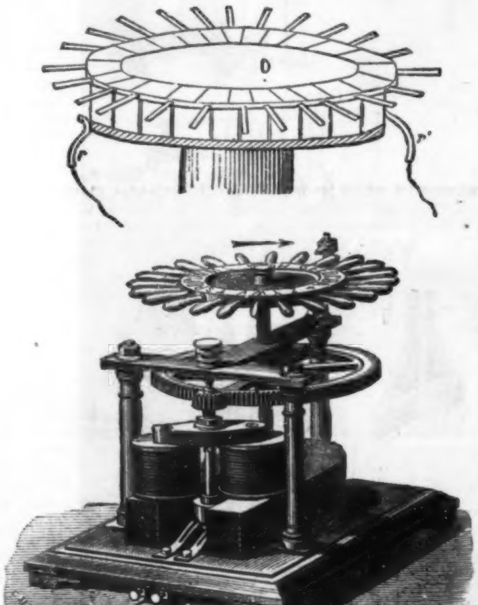


FIG. 4.—WHEATSTONE'S TRANSMITTER.

cil in motion. The porcelain tablet is afterward moved by hand to the right, and the clockwork is at the same time set running by means of a catgut cord. This mechanism, when the hand is removed, causes the tablet to move forward gently while the pencil inscribes thereon zigzags whose different sizes and relative position correspond to the letters of a special alphabet.

"To this apparatus is joined the little dictionary of the academician Jacobi.

"The apparatus was, in 1839, placed upon the first Russian subterranean telegraph line and operated between Nico-



FIGS. 5 AND 6.—LATER FORMS OF WHEATSTONE'S TRANSMITTER.

las the First's cabinet (at the Winter Palace) and the Etat-Major."

The electro-magnet of this apparatus, as may be seen, had considerable work to accomplish, and for this reason alone the apparatus was impractical. It constitutes, nevertheless, an interesting experiment.

At the end of the same year (1839), Wheatstone, taking the path that Cooke had already entered upon, invented a dial telegraph which may be considered as the first apparatus of the kind that exhibited any certainty in its operation.

The receiver of the primitive type (Fig. 3) was formed of

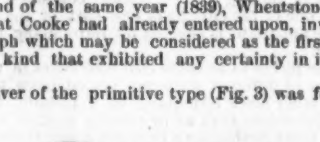


FIG. 7.—WHEATSTONE'S COMMUTATOR.

two electros, E E', whose two armatures, A A', were capable of oscillating upon a lever, A A'. The axis of rotation of this latter carried the anchor escapement of a clockwork movement which caused a needle, I, to move in front of a dial that caused letters and figures.

The electros, E and F', operating turn by turn under the influence of currents sent alternately into each, the needle moved forward one letter at each oscillation of the lever, so in order to designate any character, it was only necessary to stop for a moment at such character, while keeping the circuit closed.

The current thus entered the receiver, now through the wire, F, of the electro, E, and then through the wire, F', of the electro, E', and made its exit through the return wire, C. The currents were sent by means of the transmitter shown in Fig. 4. A large-toothed, metallic wheel, R, carried the letters and figures inscribed upon its circumference. The mass of this wheel communicated, through the wire, *d*, and through the pile, with the return wire of the receiver. Two springs, T and T', were connected with the wires, F and F', and were, in addition, arranged in such a way that when one was in contact with one of the teeth of the wheel the other corresponded to one of the intervals. If, then, the wheel was revolved by taking it by the rods placed in front of each letter, the current was sent, now into the wire, F, and now into the wire, F', that is to say, it alternately actuated the two electros, and thus produced a progressive motion of the needle. The rod, *p*, was a reference point before which was brought the sign + in order to put the apparatus back to zero. In the receiver, the needle had likewise to be brought in front of the same sign in order to establish a concordance between the two apparatus.

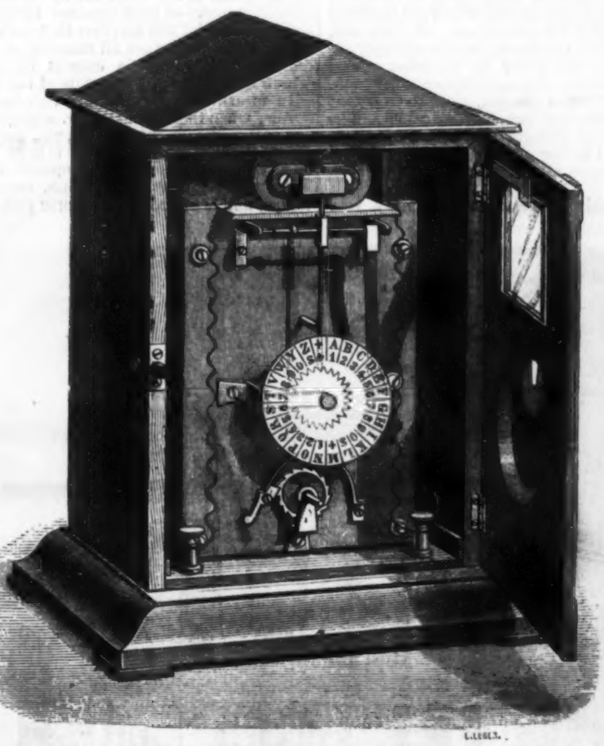


FIG. 8.—WHEATSTONE'S DIAL TELEGRAPHIC APPARATUS, IMPROVED.

This dial telegraph was patented in January, 1840, and its inventor quickly made a number of modifications in it. One of these is shown in Fig. 8. Here a clockwork movement tends to cause the revolution of a disk upon which are inscribed the letters and figures. The electro is placed above the case that contains the wheelwork, and its armature, fixed to a rod that is carried by a horizontal axle, is held away from the electro by a flat spring that acts upon it.

The motions of the rod of the armature, produced by the successive attractions of the latter, regulate the running of an escapement wheel mounted upon the same axle as the disk, and cause it to move forward letter by letter in front of the aperture in the door of the apparatus. In this case there was no more need of sending the current alternately into the two electros, and it sufficed to close and break the current. The transmitter had in consequence been simplified, and presented the appearance shown in Fig. 5. It was a disk, that carried the corresponding letters and figures, but it was horizontal, and communication between the line wires was effected by means of two springs, *r* and *r'*, one of which bore constantly upon one ring, and the other upon projections corresponding to the letters.

In another apparatus, identical with the preceding, the dial was stationary, and the wheelwork caused a needle to move forward in front of it, as in the first type. Wheatstone likewise employed for his apparatus an electro transmitter such as is illustrated in Fig. 6. It was a sort of Clarke machine, controlled by a letter wheel that carried a handle opposite each letter. This wheel was revolved until the handle of the letter to be transmitted came opposite a reference mark. While an interval between the handles was passing before this mark, the bobbins made a quarter-revolution, and this corresponded, relatively to the line and receiver alternately, to one emission of the current and one complete interruption.

The transmitter therefore acted like an apparatus that produces the opening and closing of the circuit of a pile current, and produced the same effect as the preceding. In order to have the currents emitted all of the same direction, and, at the same time, all interrupted at every quarter-revolution, Wheatstone sent them into the line through the intermedium of a special commutator (Fig. 7). The two springs, R and R', bore against an insulating disk that carried inlaid pieces of metal, the two external ones of which communicated with the extreme wires of the bobbins, while the internal ones were connected with each other. During one quarter-revolution the springs bore upon the latter, and the line was closed, and during the following quarter-revolution they rubbed against the external pieces of inlaid metal and took up the current. At every half-revolution these pieces of metal changed springs; but, as the direction of the current changed at the same time, it followed that the currents emitted were always of the same direction.

The construction of these dial apparatus led Wheatstone directly (after 1840) to the making of a new departure in telegraphy, in the invention of a printing apparatus. This telegraph is shown in Fig 9. It was only a modification of the apparatus shown in Fig. 8, and contained the principal parts found in that. The revolving disk was in this case of thin

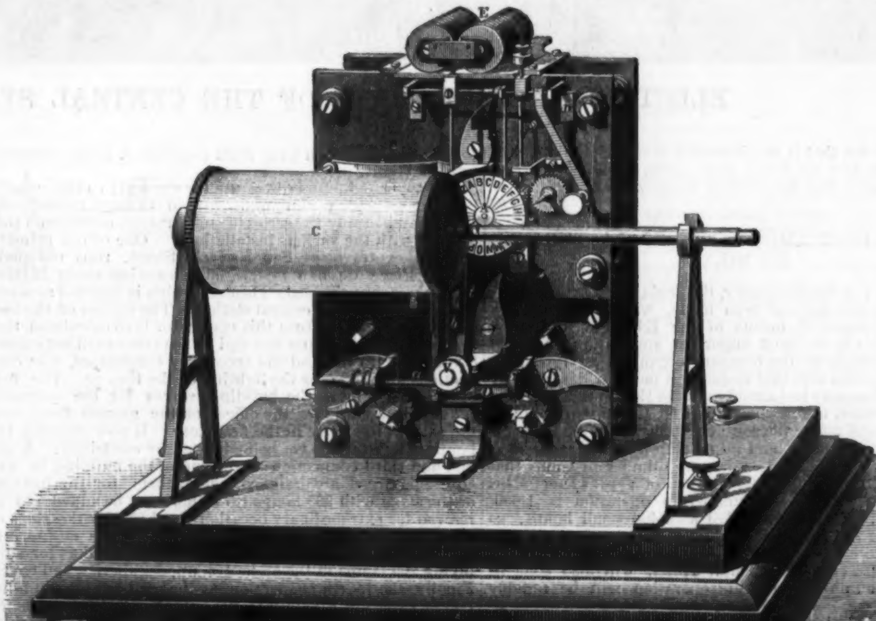
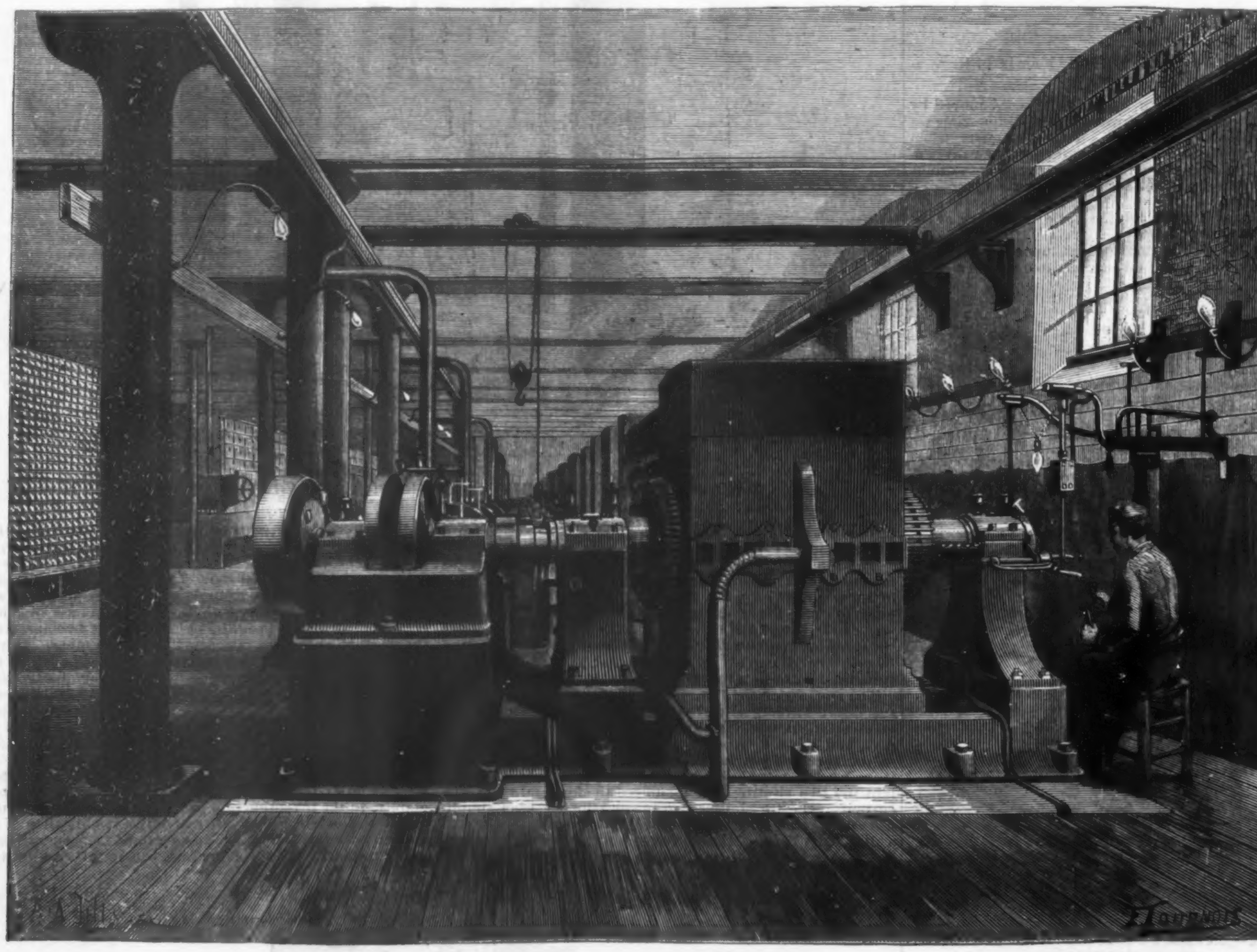


FIG. 9.—WHEATSTONE'S PRINTING TELEGRAPH.

copper cut out into a large number of sectors, each carrying a character in relief. The letter to be transmitted was first brought to a given point situated opposite a cylinder, C, and then a second electro, placed behind the apparatus, was acted upon. This electro, upon attracting its armature, freed a train of wheels which brought about the revolution of a long pinion that geared with the wheel of the cylinder, C. The axle of this latter being threaded, C moved forward upon it at the same time that it rotated. The wheelwork, while causing the cylinder to move, acted through the intermedium of a rod, *b*, upon an eccentric fixed to the axle, *a*. It thus bent a spring that carried a rod, *t*, which terminated (behind the disk and opposite the letter to be transmitted) in a small hammer. A moment after the rod, *b*, had escaped a cam, and the spring received its liberty, the hammer pressed the letter in front of it firmly against the cylinder. As the latter was covered in the first place with a sheet of white paper and then with paper smeared with graphite, the shock printed the letter in graphite upon the white paper.

The two cylinders were naturally acted upon by the aid of two different circuits. Wheatstone shortly afterward modified his apparatus so as to employ but one circuit. To this end, the current was first sent into the electro that freed the cylinder, and the motion that set this latter in operation caused the revolution, at the same time, of a movable contact, which, when the unlocking was once effected, sent the current into the electro of the telegraph properly so called. The letter to be transmitted was brought to the desired place, and the hammer was freed by the play of the cam only after a certain time, so as to permit a complete motion of the disk to take place.

However primitive be this apparatus, it is certainly very interesting to see that it was invented at so early a date, and the more so in that we find in it the germ of modern printing apparatus.—*Aug. Guerout, in La Lumiere Electrique.*



ELECTRIC MACHINE ROOM OF THE CENTRAL STATION AT MILAN.

ELECTRIC LIGHTING OF THE SCALA THEATER AT MILAN.

ON the 26th of last December, the Scala Theater, conformably to a promise that had been made, was lighted for the last carnival season by means of the Edison incandescent lamp. As this is the most important application that has been made in Italy by the company organized to introduce the Edison system into that country, it merits a description. The Italian company had already put the Edison light into the Manzoni Theater, into several stores on the Corso Vittorio Emmanuel, and under the southern gallieries of the Place du Domo, into a few cafes, and into a club house situated near the Place de la Scala. The largest number of lamps that were lighted during the representations of Verdi's Don Carlos was 2,062, but usually the number in operation is 1,600. The Manzoni Theater is provided with 400 small lamps; so that counting the lamps in operation, the number all told (including stores, etc.) is about 3,000. As the foyer of La Scala, as well as the Continental Hotel, will also soon be lighted, the number of lamps in operation will be notably increased.

The central station that supplies these different installations is situated at the beginning of Santa Radegonda Street, and has a superficies of 18 by 48 meters.

In the basement about two meters below the level of the street are placed the Edison dynamos that furnish the current. These at present are but four in number, but with the extension of the system anticipated by the company, this number will be increased to six. On the ground floor are placed five inexplosible steam boilers of the Belleville type, each of which suffices for two dynamos. In the upper story are the stores and depots.

The dynamos are of the most recently improved type, and each one of them is capable of supplying 1,000 or even 1,200 16 candle lamps, and consumes from 120 to 140 horse power.

The armature is 0·75 m. in diameter and revolves with a regular velocity of 350 turns per minute. As shown in the engraving, the dynamos are placed in a row along one of the sides of the hall, and are actuated by distinct motors in a line parallel with them. On the other side are the collectors, which are connected together for quantity by means of two large horizontal conductors, that is to say, one of the conductors is connected with all the positive brushes of the dynamos, and the other with all the negative ones.

These conductors are thus kept at a difference of potential equal to that of the from 110 to 120 volts which exists between the poles of each dynamo running, and receive the entire current of 300 amperes that each of the latter gives. When the dynamos are all running at the same time, there consequently results a current of nearly 1,200 amperes, which is regulated by rheostats of the Edison type.

In measure as the needs of lighting diminish, as, for example, when the theaters close, a proportionately less number of dynamos is run. However, during the hours of service a supplementary machine is kept running very slowly, so as to be always ready to operate if occasion requires it.

Another small reserve dynamo, capable of supplying 500 lamps, and actuated by a 20 horse power motor, is designed for serving the Union Club from one o'clock in the morning until daylight.

The two conductors distribute the current to eight principal wires, which run underground through the adjacent streets, and supply the series of subterranean conductors that connect with the various installations. One of the primary conductors traverses San Raffaele Street, runs obliquely across Place de San Fedele, and, running along Marino Palace, reaches the Scala Theater, which is situated at about 400 meters from the central station. The section of the bars of copper that constitute this conductor is so calculated that the loss of tension from one end to the other shall not exceed 8 volts. With this and the secondary conductors, four connections are made for the lighting of the theater. The first of these, in front of the building, serves for the entrance, the cafe, the vestibule, the offices on the ground floor, and the halls of the foyer in the first story. It now supplies 118 lamps, the foyer not yet being lighted by electricity. A second and third connection at the end of the building in San Giuseppe Street are designed, one of them, for the lighting of the stage with 965 lamps (to which must be added 126 in reserve for extraordinary occasions, and 253 for the sides of the auditorium), and the other for lighting the auditorium by means of a large 344 lamp chandelier, as well as for supplying 209 lamps in the orchestra, upper galleries, and boxes. Finally, the fourth connection, at the end of the building facing Place des Filodrammatici, supplies 396 lamps in the courts and entrances on this side, the painters' and machinists' rooms under the theater, the artists' boxes, etc. At the present time, therefore, there are 2,411 lamps disposable in the theater, with a total illuminating power of 34,850 candles or nearly 3,500 Carcel burners.

As a general thing, the stationary lamps are fixed at the extremity of the supports that were used for lighting by gas. The principal lamps (those of the chandelier, orchestra, footlights, stage, etc.) are all 16 candle ones. Those of the boxes, galleries, and border lights are of 10 candle power, and, as they have a difference of potential equal to that of the others, they are, like them, placed in a derived circuit.

The stage is lighted with fixed lamps in the footlights, and movable ones in the strip and border lights. That part of the border that carries the lamps is painted white so as to serve as a reflector. The strips are long wooden planks that are placed behind the side scenes and support the Edison lamps through small metal catches. Alongside of the striplights there is a vertical iron rod which slides in a system of rings that guide it. On a level with each lamp the rod carries a catch that holds cylindrical jackets of sheet iron or colored or opalized glass of sufficient size to hold the lamp. When the rod is lowered these jackets are alternate with the lamps, but when it is raised they surround them either wholly or partially. By this means the light from the lamps of one of the strips can be suddenly shut off, or reduced, or colored by means of the colored glasses.

The lamps of the stationary apparatus are placed upon as many derived circuits, that start from their respective connections and have a regulator for each. As the number of movable apparatus changes from one moment to another, in order to produce a bright light or almost complete obscurity it is necessary that there shall be some easy and prompt means of removing one of them when necessary. To effect this, a portion of the circuits designed to supply these apparatus ends in the rooms occupied by the machinists, and the others are under the floor of the stage and are provided at their extremities with metallic couplings. These circuits are protected by a covering of wood, and are provided with a safety apparatus made of fusible lead wire in order to prevent all danger from fire. These flexible conductors serve to unite the distributing circuits with the movable apparatus. The joining of one flexible conductor with the coupling of one of the circuits of one part or the other of the movable apparatus is effected by introducing them one into another.

One of the pieces to be connected terminates in two copper cylinders of different diameter placed upon the same axis. The other piece terminates in a metallic cavity of form and dimensions such as to exactly contain the cylinders. The latter having been once fitted into the cavity of the other piece, their adherence is secured by means of a screw collar. The flexible conductors that carry one these couplings at one extremity, and the other at the other, are of equal dimensions, so that any one of them can be coupled to the circuits of any strip light or border light whatever. In this way the various maneuvers connected with changing, adjusting, and moving the apparatus can be easily effected in a few moments. The regulators on each circuit are rheostats of the Edison type, made of galvanized wire wound in long spirals upon a series of prismatic pieces of wood covered with asbestos, and serving to introduce, as need be, into each circuit a resistance seven or eight times greater than its own. The intensity of the current may therefore be varied as required, and that of the lamps that depend upon it be diminished or increased to any degree. The lamps of a partial circuit may also be extinguished, and those of another be lighted in order to distribute the light and shade required for the different scenic effects. To effect this, the thirteen regulators are placed in two rows, one of seven and the other of six, in a small room at the side of the stage

toward San Giuseppe Street. In a small room above this are placed the contact commutators, which, by means of a key, serve to introduce into the different circuits a fraction of the resistance of the rheostat placed underneath.

Owing to the ingenious arrangement of this commutator, the resistance of a series of circuits can be increased or diminished, or modifications be effected in any one of them. At the same time, by means of the lever, each of the circuits may be regulated independently of the others. These maneuvers are executed at the proper moment according to orders given through a speaking tube or bell by the director of the theater. In addition to the fixed regulators, there are others for the strip and border lights that may be added in special cases. These regulators are portable, and are placed at the desired moment on their respective circuits.

Aside from the advantage that there is in being able to thus make the requisite changes for the stage with promptness and ease, there is another important one that concerns the economical side of the question, and that is the small consumption of lamps. Very few of these latter have been put out of service during the season that has just closed. From the fact that they were not submitted long to a maximum intensity, it seems that a greater duration has resulted. In fact, the maximum duration that has been ascertained up to the present is 2,500 hours for stage lamps, and 3,400 for those of the chandelier—a result that is truly notable.

The diffused light from incandescent lamps is very agreeable, on account of its color and steadiness. The temperature of the theater is no longer suffocating, especially in the upper boxes and galleries, and the air is perceptibly purer, owing to the fact that it is not contaminated by any products of combustion as it is when gas is used. The decorations, varnish, and gilding are no longer deteriorated, as before, by the emanations from gas, and, what is most important, danger from fire is nearly suppressed. Perhaps electric lighting costs a little more than gas, but the above advantages compensate largely for the increase in expense.—*La Lumière Electrique.*

JEAN BAPTISTE DUMAS.

ANOTHER of the few remaining *savants* who have been the contemporaries of Berzelius, Davy, Dalton, Gay-Lussac, and Bibot, has passed away from our midst. On the 11th of April Jean Baptiste Dumas concluded his honorable and useful career. He was born at Alais in 1800, and, like Liebig, he began his chemical career in the establishment of a pharmaceutist. Here, in his twentieth year, he entered upon physiological research, and published in conjunction with Prevost the results of a series of experiments on the blood. But, as M. Wurtz remarks, "pharmacy did not absorb him, and physiology could not retain him." He removed to Paris in 1821, devoted himself entirely to chemistry, and became the pupil of Gay-Lussac. He was soon in a position to undertake successfully the most important investigations. With him there began in chemistry a new development amounting almost to a revolution. The views then dominant had been founded exclusively upon the relatively simple study of mineral compounds. All compounds were supposed to be formed of two proximate elements, which might be either simple bodies or combinations of a lower order. The illustrious Swedish chemist, Berzelius, who in the earlier part of the century exercised an uncontested authority, had developed this dualistic hypothesis, and had based it upon his electro-chemical hypothesis. In 1834, however, Dumas, studying the action of chlorine upon certain organic compounds, found that this element "possessed the singular power of combining with the hydrogen of such bodies and of replacing it atom for atom." This was the first announcement of a law which is now founded upon thousands of analogous facts, and which is the keystone of the theory of substitutions. Laurent and Gerhardt ably assisted in the elaboration of this new doctrine. Berzelius opposed it from the very first with all the weight of his ability and his influence. The idea that an electro-negative element like chlorine could take the place of an electro-positive element like chlorine ran counter to his firmest convictions, and, in fact, was necessarily fatal to the entire dualistic system. It involved a new way of regarding chemical combinations. To Berzelius they had appeared as double entities; to Dumas they were unitary structures which might remain unshaken though a course of stones was replaced by other materials. This conception Dumas developed in a series of memoirs on chemical types, a notion which has since been simplified and generalized. In short, it must be admitted that in the creation of what has been called the new or the post-Lavoisierian chemistry, Dumas played a great—perhaps the greatest—part. It is natural that such a transformation could not be effected without a prolonged and obstinate controversy, and we owe abundance of valuable investigations to the quest for arguments, on the one side to sustain, and on the other to refute the new views.

This capital discussion, however, by no means sums up the scientific career of Dumas. We find him engaged with the redetermination of atomic weights and with the examination of the law of Prout. He improved existing analytical methods, and may be pronounced one of the fathers of gas analysis. He discovered also not a few organic compounds, which, as Professor Wurtz well remarks, are not isolated beings, but heads of families, the representatives of certain general properties or of certain functions. Thus, in 1830, he discovered oxamide, and in 1835 he studied wood spirit in conjunction with his pupil Peligot, and recognized its character as an alcohol.

To his early physiological researches we have already referred. But it must not be forgotten that in his lectures on organic chemistry at the Faculty of Medicine he treated the reactions of the animal economy from a general and an elevated point of view, balancing the losses and the gains, and laying the foundations of the chemical statics of living beings. "These memorable teachings," says M. Wurtz, "have exerted a permanent influence, and have introduced into physiology exact methods."

In physics he will be remembered as the inventor of a new method for the determination of vapor densities.

As a teacher of chemistry he takes an exceedingly high rank. Soon after his arrival at Paris he opened a class at the Athénée. Subsequently, in conjunction with Lavallée, Ollivier, and Péclet, he founded the Central School of Arts and Manufactures, where he taught chemistry for more than twenty-five years. In 1832 he succeeded Thenard at the Polytechnique, and was called in the same year as "Adjunct Professor" to the Faculty of Science at Paris. In 1841 he became Titular Professor and Dean of Faculty. In 1844 he succeeded to the Chair of Organic Chemistry at the Faculty of Medicine. Here it was that his professorial career culminated. He was then in the most brilliant epoch of his creative activity. His hearers were fascinated at once with the grandeur and the novelty of his ideas, and with the eloquence and clearness of his exposition.

As may well be imagined, he was often consulted by the Government of the day whenever chemical or physical advice was essential. Before 1848, as Government Commissioner, he had to ascend the Tribune in the Chamber of Deputies, and explain the whole mechanism of coinage, with reference to a bill before the Chamber. Notwithstanding the dryness of the subject, the assembled deputies listened eagerly to a speech which lasted two hours. More recently he was a member of the commissions on the international use of the metric system and on the establishment of electric units.

In addition to his very numerous memoirs in the *Comptes Rendus* and in other scientific journals, two of his works have become classical—the "Traite de Chemie Appliquee aux Arts" and the "Leçons de Philosophie Chimique," which M. Wurtz styles an "incomparable volume."

The honors which he well merited were not wanting. On the death of Flourens he was elected one of the perpetual secretaries of the Academy of Sciences. On the decease of Guizot he succeeded to his vacant chair at the Academie Francaise—a body which, though its members are for the most part inferior in intellect and in celebrity to those of the Academy of Sciences, is still regarded in France as the superior body.

In 1863 Dumas received from the Emperor Napoleon the Grand Cross of the Legion of Honor. In 1840 the Royal Society elected him a foreign member; in 1843 the same body awarded him the Copley Medal, and in 1869 the Chemical Society awarded to him the Faraday Medal.

JEAN BAPTISTE DUMAS.

At his funeral discourses were pronounced by M. le Compte d'Haussonville, on behalf of the Academie Francaise; by M. Bertrand, his fellow secretary at the Academy of Sciences; by M. Rolland, President of the Academy of Sciences; by Professor Wurtz, as representative of the Faculty of Sciences and the Faculty of Medicine, of Paris; and by M. Melsens. But the researches of the late chemist are after all his true and his most eloquent eulogy.—*Chem. News.*

MODERN METHUSELAHS.

By Dr. G. ARCHIE STOCKWELL.

SCRIPTURE indicates that in the earlier periods of the world's history the ordinary duration of human life was from six to nine hundred years and upward. After the deluge, however, there was a woeful falling off in years; Shem alone, as far as we can gather, living to celebrate his fifth centennial, while the average would appear to be less than two hundred years. Again, in the third century after this great cataclysm, we find a continued decrease, and one Terah justly celebrated as having completed two full centuries of life.

There are many reasons, however, chief among which is the Oriental and traditional character of the Biblical record, which tend to throw discredit upon these accounts, and the number is far from few that openly assert their mythological and apocryphal character. But, be this as it may, we find that from the days of the great lawgiver Moses down to the present era, the years allotted to man are scarce more than threescore and ten, or at most fourscore. Ancient history indicates that Sophocles at eighty nine, and Plato at eighty one, were "old men;" as also were Socrates and Solon at seventy-two and seventy-six respectively. The age of Hippocrates, who completed his one hundred and fourth year, and that of Galen at one hundred and forty one, cited as most remarkable incidents, and as glorifying the profession of medicine, which is justly held to have been founded by these worthies. It was their skill in the healing art that caused their names to be handed down to us, rather than their years, since both Marc Alburia, of Ethiopia, and Titus Fullonius, of Rome, have obtained no prominence in history, though both lived upward of one hundred and fifty years.

Lord Bacon singled on the year A.D. 76 as one of the most remarkable in the world's history, not only because it gave birth to new and more equitable methods of taxation, as introduced throughout the Roman Empire by Vespasian, such being based upon the age of the individual; but also because this method revealed a remarkable number of people who had more than completed a century of years. In the Apennine provinces of Italy alone were found one hundred and twenty-four to be classed in this category, viz., fifty possessed ages varying from one hundred and three to one hundred and ten; three confessed to one hundred and twenty-five; fourteen ranged from one hundred and thirty to one hundred and thirty-six; three more were found at one hundred and forty; and one, Marcus Aponious, at one hundred and fifty.

Of our own century no data are as yet established whereby a just estimate may be formed; but the three previous centuries are somewhat prolific in centenarian examples. Louisa Truxo, for instance, a negro woman of Brazil, leads the list as having completed her one hundred and seventy-fifth year in 1780; and though satisfactory evidence of subsequent life is wanting, it is claimed that her life was prolonged at least fourteen years more.

Next comes Henry Jenkins, all his life either a peasant farmer or a mendicant, a native of Yorkshire, England, who was born A.D. 1500, and died December 3, 1670, or at the age of one hundred and sixty-nine years past, beating the famous Thomas Parr of forty-five years before, and John Bowles, of Killingworth, who died twenty-five years later than Parr at the same age, by seventeen years and one month.

Francis Consist, another Yorkshireman, passed the way of all the earth in 1768, aged one hundred and fifty. Col. Thos. Winslow, deceased in 1766, enjoyed the beauties of the "Emerald Isle" for upward of one hundred and forty-six years; and Christian Drakenberg attained a like ripe age sixteen years later in Norway. In 1782, one Evan Williams, aged one hundred and forty-five, was living as an indigent pauper in the workhouse at Caermarthen, Wales, but no account of his death is extant. One Ecleston, too, died in Ireland in 1691 in his one hundred and forty-fourth year; and just a century later Abe Baiba, a free negro, celebrated his one hundred and forty-second anniversary at Charleston, S. C.

Six persons are known to have completed one hundred and forty years of life during the eighteenth century, viz., Damitur Raduly, of Haromszech, Transylvania; M. Laurence, of Oreades, Scotland; a French gentleman of foreign extraction named Goldsmith; M. Gulstone, an Irish magistrate; and Jemmy Sands, of Staffordshire, who however cannot be the Jemmy Sands made famous by song, since his wife lived to be one hundred and twenty. Margret Patten, of Lockneugh, near Paisley, lived one hundred and thirty-eight years. Johnny Mount, another canny Scot, was but two years her junior at the time of his death, which occurred in 1766, while Margret Foster of the same age, along with a daughter of one hundred and four, were living in Cumberland in 1771, and for all evidence we have, may have had their lives prolonged some years thereafter. Rich. Lloyd, of Montgomery, was one hundred and thirty-three; John Brookey, of Devonshire, his junior by a single year; Mary Yates, of Shropshire, died æt. one hundred and twenty-eight in the year of American Independence; William Elles, of Liverpool, two years older, followed three years later; John Bales, of Northampton, confessed to one hundred and twenty-six in 1766; an inscription on the tomb of Margret Scott, at Dalkeith, Scotland is evidence she completed a century and a quarter of years—the same age as John Tice, of Worcestershire, who died in 1774; and no less than twenty-four persons are known to have resided in England during the last century who ranged through various ages from one hundred and four to one hundred and twenty-three. William Walker served as a private soldier at the battle of Edgehill when in his one hundred and twelfth year; Sergeant Donald McLean, a soldier from early boyhood, came to America in his one hundred and third year to serve under Sir Henry Clinton in the war against the Colonies; he was, however, sent back as a bearer of dispatches, and with a handsome pension provided by this officer from his own income. Strange to say, though all other faculties were perfect to the day of his death, McLean could never remember the number of his offspring.

Thomas Parr, or, as he is familiarly known, "Old Parr," is everywhere cited as the oldest man of modern times, a distinction that was not his by right, and obtained probably from the prominence given him in history through the introduction to, and notice afforded by, his sovereign. True, for twenty-one years he was entitled to such distinction, when the death of Bowles procured for him a rival, while both were eclipsed by Jenkins a quarter of a century later. Further, Parr was buried in Westminster Abbey, while his rivals obtained no more post-mortem courtesy than was afforded by the Potter's Field.

Of the history of Parr but little is known, but, as a peasant yeoman and the son of John Parr, of Winnington, in the parish of Alderbury, county of Salop, Shropshire, it was presumably uneventful enough. When seventeen years of age he went out to service, remaining in the employ of the one farmer eighteen years, when he returned home to take charge of his father's holding, the latter having become too aged to give it personal supervision. Four years later the lease expired, when it was renewed by Mr. Lewis Patten to Thomas Parr, then in his thirty-ninth year, said lease bearing the date of 1522; and this in turn was renewed in 1543 by Mr. John Patten; and again of Hugh Patten in 1585; and subsequently (date unknown) by this latter gentleman's son—four generations of landlords.

When eighty years of age, Parr first felt the wounds of Cupid's darts, and he courted and married one Jane Taylor, presumably a lass in her teens, since she is described as a "young maiden," a term that in these days would be deemed inadmissible to one who had completed her fifteenth year, when she would be entitled to the matronly designation of "mistress," irrespective of conjugal bonds. Jane died in 1595 after thirty-two years of connubial bliss, having borne her spouse two children, both of which died at an early age.

In his one hundred and sixth year an illegitimate child was born to Parr as the result of a liaison with one Katherine Milton, for which indiscretion he was made to do penance in Alderbury Church by standing before the congregation several Sabbaths in succession enveloped in a white sheet.

After being twenty years a widower, and when at the modest age of one hundred and twenty-two, Parr again succumbed to the wiles of the "little god," and assuaged his grief by a marriage with one Jane, widow of Anthony Adda, and daughter of one Lloyd of Gilfells, Montgomeryshire. She also was of a long-lived family, being a niece of Richard Lloyd, a centenarian, before mentioned; and she survived her husband many years.

Unfortunately for the old man, during the last year of his life he attracted the attention of the Earl of Arundel and Surrey who was engaged in hunting up human curiosities and monstrosities for the delectation of his royal master, Charles the First. The Earl forced him, much against his will, to accompany him to London, a most formidable journey for the times and considering the condition of the roads throughout the kingdom; and we are told he had for company another curiosity in the form of a man described as an "antique-faced fellow, with a high and mighty nobeard"—whatever that may be.

When brought before the King, the latter, with the usual abruptness and lack of courtesy that ever marked the Stuarts, demanded: "As you have lived longer than other men, what have you done more than other men?" To which Parr replied, having reference to his unfortunate amour with Katherine Milton, "I did penance when more than one hundred years old." Henceforth he was commanded to live in London as a royal protege under the care of Arundel,

who aimed to make life as agreeable as possible for him; but wines and strong liquors, coupled with foggy atmosphere, late hours, and erratic habits, soon worked a sad change in the man who was accustomed only to home brewed ales, regular habits, and the pure air of the Shropshire hills; and he finally expired November 5, 1635, having survived nine sovereigns, of whom the first was Edward the Fourth, and anticipating the execution of the tenth by only a trifle more than fourteen years.

Parr is said to have been an under-sized man, not more than five feet six in height, though somewhat stoutly and compactly built, and

"From head to heel his body had all over
A quick set, thick set, natural hairy cover."

The poet Taylor further describes his life:

"In mire and toiling sweat he spent the day,
And to his team he whistled time away:
The cock his night clock, and 'till day was done
His watch and chief sun dial was the sun.
He was of old Pythagoras' opinion
That green cheese was most wholesome with an onion.
Coarse meslin bread, and for his daily swig
Milk, buttermilk, and water, whey and whig:
Sometimes metheglin, and by fortune happy,
He sometimes supp'd a cup of ale most nappy,
Cider or perry, when he did repair
T' a Whitsun ale, wake, wedding, or a fair,
Or when in Christmas time he was a guest
At his good landlord's house among the rest;
Else he had little time to waste,
Or at the ale house huff-cup ale to taste.
His physic was good butter, which the soil
Of Salop yields, more sweet than Candy oil;
And garlic he esteemed above the rate
Of Venice treacle or best mithridate.
He entertained no gout, no ache he felt,
The air was good and temperate where he dwelt;
While mavises and sweet tongu'd nightingale
Did chant him roundelays and madrigals.
Thus living, within bound of nature's laws,
Of his long lasting life may be some cause."

It is commonly charged that "old Parr died from surfeit, and that had he not been removed to London he might have completed the second century, or at least survived the unfortunate monarch he came to visit. The first assertion is utterly without foundation, and the second, to say the least, extremely problematical. Indeed, some doubts may be expressed as to whether his death was hastened in any material degree, or more than a few months at most, since it is directly traceable to a disease peculiar to old age from which he had long suffered. All his life the man had been accustomed to eat ravenously, even hoggishly, and at frequent intervals, after the manner of the Shropshire peasantry, indulging in heavy feeds, sometimes four or five times a day and once or twice during the night. Parr frequently rose at midnight to lunch off bread, milk, whey, ale, and old cheese—a conglomeration fit to give a Samson the nightmare or a Marquesian cannibal a fit of indigestion. At the autopsy that followed his death, made more as a matter of curiosity than as a scientific necessity, it was discovered that the digestive organs were in a perfectly healthy state, but that the lungs were congested with pluritic effusion, while the kidneys were the seat of numerous abscesses, one of which rivaled a hen's egg in point of size.

Up to his one hundred and thirtieth year, Parr worked continuously in the fields, finding few equals in the husbandman's art; and he was held an expert in the use of the sickle and flail, cutting or thrashing out more grain than many of his younger compeers. About this time, however, his eyesight began to fail, and memory prove fickle and uncertain. When taken to London he was totally blind, deeply sensitive to all but the highest of temperatures, fickle and uncertain in mind, collecting his mental faculties only by a powerful effort: he could, however, converse quite intelligently, if uninterrupted, following only one line of thought; but the thread of the conversation once broken, there was little hope for a renewal.

In the later days of the nineteenth century, the number of persons who have more than accomplished a century of years appear to be multiplying. In the city of Guadalajara, Mexico, there resides a "Greaser" who claims to have been present at events that took place in that city in 1740, and he certainly evinces therewith all the familiarity of an eye witness. Another resides in Sonora, one hundred and twenty-seven years of age, in perfect health and full possession of all his faculties, and who passes his time in rolling innumerable cigarettes for himself and friends. Two distant relatives of the writer are still living, at the advanced ages of one hundred and three and one hundred and seven respectively. Sojourner Truth, a negress, of Battle Creek, Michigan, claims to be one hundred and ten, and is somewhat celebrated as an evangelical exhorter and temperance lecturer. I have known also two squaws who attained a great age; one, known as "Old Mother Rodd," resided on the Ojibbeway Reservation, near Sarnia, Ontario, and died a few years since at, as supposed, one hundred and twenty years; the other, a Sateaux witch or medicine squaw, who was murdered in her one hundred and twenty-fifth year by a French half-breed she had threatened to bewitch—an act that was generally applauded, since she was feared by the Indians and mixed bloods for miles around.

Were I to go beyond the bounds of personal knowledge, I doubt not that centenarians of the present century might be multiplied indefinitely; but this would be trespassing on the domain of the daily and sensational press; and if these reports furnished us are to be credited, the duration of human life would seem to be rather on the increase than otherwise.

SUBMARINE EXPLORATIONS.*

A REMARKABLE example of the immense geographical distribution of which certain genera of crustaceans are susceptible is furnished by the lithodes. These animals have hitherto been found near the surface in the seas of the north and south poles. We found them in the tropics. But, here, in order to find the vital conditions necessary for their existence, they had deserted slight depths, and gone to live at those of a thousand meters. This fact is of extreme importance as regards the distribution of life in the ocean. It shows us, in the first place, that some animal forms extend from the Arctic seas down to the tropics, and secondly that, in order to succeed in living at these latter stations, animals of the north and south poles have only to continually descend in the sea in measure as they approach warm regions, and thus keep themselves in a zone whose temperature is adapted to their organization. We shall note the same fact in speaking of mollusks.

The *Paguri*, commonly known by the name of hermit crabs, have been found at as low a depth as 5,000 meters. As well known, the body of these crustaceans is provided with a shell only at the head and thorax, so, in order to protect their soft-skinned abdomen, these animals take up their lodgings in shells whose size is proportioned to their own. But, as shells at great depths are of small size, the hermit crabs that live there are capable of sheltering their abdomen only very imperfectly. One of the species of *Pagurus* taken off the coast of Morocco and in the Sargasso Sea has a very peculiar habitat. It takes up its quarters, not in a shell, but in a true animal colony formed of those elegant creatures called epizoanthes. These latter develop in the first place upon a shell whose testa becomes progressively absorbed, and it is in the cavity that corresponds to this that this very peculiar species of hermit crab ensconces itself.

Galatheans were found in profusion in all zones. The color of their body, which is reddish, becomes white in such of these animals as live at very great depths. Certain species establish themselves as lodgers in the interior of those beautiful silicious sponges, the *Aphrocallistes*, whose tissue resembles lace. *Galathodes Antonii*, a new species (Fig. 2), was taken at a depth of more than four thousand meters. *Ptychogaster formosus*, A. M. Edw., shown in Fig. 3, appears to us interesting because of its coiled abdomen. The group of Eryonides was represented by a considerable number of genera and species. The *Polycheles* and the *Wilmasia*, whose delicate tissues possess such transparency that their stomach may be seen through their sides, were taken at depths of between four and five thousand meters. The *Pentacheles*, which are very common at between one and two thousand meters, exhibit forms very analogous to those described in the fossil state under the name of *Eryon*. At the Talisman exhibition there is placed alongside of a *Pentacheles crucifer* a slab of limestone from the Jurassic deposits of Solenhofen in Bavaria, upon which is seen the impression of an *Eryon*. A comparison of these two specimens shows their resem-

FIG. 1.—NEMATOCARCINUS GRACILIPES, A. M. EDW. (Natural Size.)

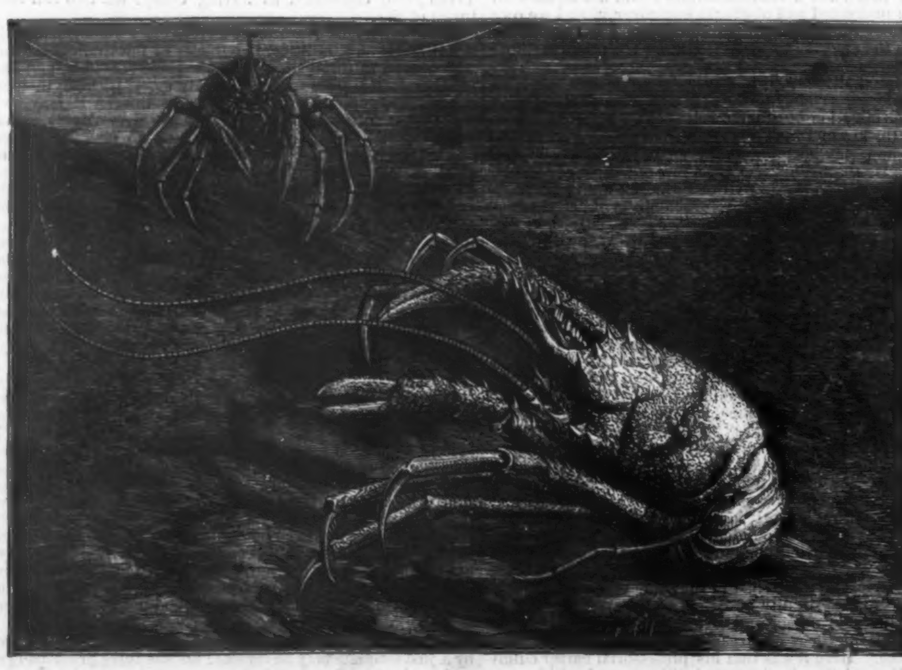


FIG. 2.—GALATHODES ANTONII, A. M. EDW. (Natural Size.)

* Continued from page 6990.

blance to be very striking. The Macruran crustaceans, a group of which the shrimp forms part, are abundant at all depths. Off the Cape Verde Islands, at a depth of five thousand meters we took thousands of a new species of *Pendala*. Among the most remarkable forms, we may cite the *Aristeus*, which are of a beautiful red color, and the antennæ of which are five or six times as long as their body, the *Nematocarcini* (Fig. 1), whose legs are enormously long, the *Oplophori*, the *Notostomi*, of an intense red color, the *Acantephyræ*, the *Pasiphae*, now brown, now rose color, often spotted with red, and finally the *Glyphi*, one species of which, *G. marsupialis*, possesses a very remarkable structure, the lateral plates of the first abdominal articulations, in the female, developing in such a way as to form a marsupial pocket designed for the reception of the eggs. Finally, among the schizopods we may mention a *Gnatauphausia* of very great size and of a scarlet color. The lower crustaceans, the amphipods and isopods, were found in quite large numbers but a study of these is much less interesting than is that of the forms of which we have just spoken. The *Nymphons* were abundant at great depths, and one gigantic form of these animals, whose stomach is prolonged up to the end of the legs (*Colossendeis titan*), was taken at a depth of four thousand meters.

On the subject of crustaceans, as on that of fishes, it is very interesting to find out whether the influences to which these animals are submitted do not lead to modifications and adaptations of their organism. Changes undergone by the tissues are often observed in the structure of the carapax and of the muscles. We have already remarked that in the *Pentacheles*, *Polycheles*, and *Wilmassiæ* the tissues are sufficiently transparent to allow the viscera to be seen, and as for their flesh, that is soft and entirely wanting in flavor. The external coloration is bright red, rosy white, or pure white. The Macrurans are especially remarkable by their brilliant colors, and we cannot escape a feeling of admiration when we observe coming out of the sea *Aristes* of a carmine-red, *Notostomi* of a pure and intense red, and *Pasiphaës* spotted with white and red.

At great depths, rosy white and pure white are the only tints that appear to exist. We have seen that in fishes the organs of vision are always perfectly developed, whatever be the depth at which these animals are taken. The same is not the case with crustaceans, as several species of these belonging to very different groups exhibit an atrophy and even a complete disappearance of the eyes. But, what is a very singular fact, we find in the same genus some species that are blind, and some that are not. Thus, *Ethusa granulata*, which lives in northern seas at a depth of between 200 and 1,300 meters, is blind, while *E. alba*, which we took in the ocean at a depth of 5,000 meters, is not. When a disappearance of the eyes occurs, it seems to take place gradually, and to be related to the depth at which the animal lives. It is the cornea that disappears in the first place, the ocular peduncles persisting and remaining immovable. Then these latter parts become fixed, lose their characters, and become converted into spines. "Thus," says Norman, "*Ethusa granulata*," taken at from 110 to 370 fathoms, has two remarkable ocular rods, smooth and rounded at the extremity where the eye is usually situated. In specimens derived from the north, and inhabiting depths from 542 to 705 fathoms, the ocular peduncles are no longer movable, but are completely fixed in thin alveoli, and their character is changed. Their dimensions are much greater, they are nearer at their base, and, instead of being rounded, their extremities end in a very solid beak. Serving no longer as eyes, they act as a beak." In Fig. 2 is shown one of these blind species, *Galathodes Antonii*, and at the exhibition there may be seen alongside of this strange form, whose eyes are represented by sharp spines, *Pentacheles*, *Polycheles*, *Wilmassiæ*, and *Cymonomi*, whose organs of vision are more or less transformed.

Crustaceans living at great depths give out a phosphorescent light that serves to guide them. This light is now emitted by the entire surface, and now, as in the *Aristeæ*, in a more special manner, by the eyes themselves. In certain of them there seem to exist at certain points of the body organs designed for producing light—a fact that recalls one of the same nature that we have noted in speaking of fishes. Thus, in a new species of *Acantephyra* (*A. pellucida*, A. M. Edw.) the legs are provided with phosphorescent bands.

As for the organs of touch, these assume considerable development, one of the most remarkable examples of which is afforded by the immense antennæ of the *Aristeæ*. In certain crustaceans, *Benthesicymnus*, for example, the last pair of legs are diverted from their functions, assume the character of antennæ, and very probably perform the same role as these organs.—*H. Filhol, in La Nature.*

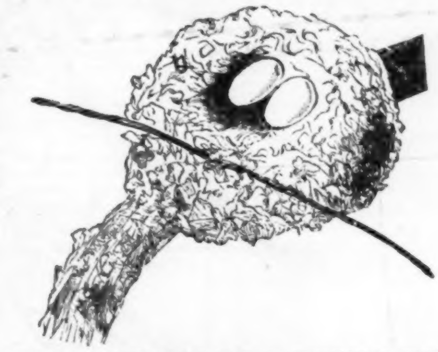
THE RUBY-THROATED HUMMINGBIRD.

(*Trochilus colubris.*)

WHAT was to me one of the luckiest finds I made last year was the nest and eggs of the hummingbird.

I had been collecting in an orchard, and thought I had ransacked it pretty thoroughly. While working my way out, a hummingbird darted past, inducing me to follow in the direction it had gone. I had not proceeded far when I saw the bird dart from a limb, and after a few moments reappear and alight on the same limb. This convinced me that there was a nest somewhere in the vicinity. Dodging carefully from tree to tree, I cautiously approached the bird and had succeeded in getting quite near, when suddenly catching sight of me, he darted away. Hastily getting as near the limb as I thought prudent, I awaited his return. In company with his mate he was soon back. By the frantic way in which they darted around my head, I was convinced that their treasure was within a few feet of me. Turning my head, I beheld the prize—so near that a step to the right would have knocked the eggs from the nest. There were two pearly white eggs, my delight in discovering which may be more easily imagined than described. When I had recovered my equanimity, I retired a short distance and sat down to watch the habits of the birds, as this was the first nest of the species I had ever found.

They soon thought I had gone, and the female returned



NEST OF RUBY-THROATED HUMMING BIRD.
(Full size, from nature.)

to the task of incubation. She would fly along until directly over the nest and about an inch above it, when suddenly closing her wings, she would drop into it and settle herself in position. The male meanwhile kept watch on an adjoining limb. I frightened the female off her nest several times for the purpose of watching this maneuver, which was repeated each time. Finally concluding that I had learned all that I could, I started forward to take the nest, when I was assailed on both sides by the infuriated mites, who darted past my face so close that I began to be afraid of my eyes. They kept chirping loudly all the time, which I see is denied by some writers, who had they been present would never have denied it again.

The nest was built near the extremity of an apple bough, and was not more than five feet from the ground. To describe the nest, I cannot do better than quote from my note book: "The nest is an exceedingly small structure, being not more than three to three and one-half inches in circumference, one inch in diameter, and half an inch deep—inside measurements—and an inch and a half high. It is composed of thistledown, willowdown, cobwebs, and caterpillar's silk. It is plastered all over the outside with lichens. The lining is of the materials named. One peculiarity of this nest is that a pine needle of extra length is just caught on to the side by a few turns of cobwebs as if for ornament, and projects from each side about two inches."—*E. M. Hasbrouk, Syracuse, N. Y.; Ornithologist.*

THE EXPEDITION TO SEARCH FOR LIEUT. GREELY.

THE idea of establishing a number of circumpolar stations for the purpose of scientific observation and practical exploration was first suggested in Europe by the late Lieut. Karl Weyprecht, commander of the Austrian Arctic expedition on board the Tegetthoff.

He thought that, year by year, the stations might be gradually advanced to the northward, and that in some favorable season a dash might be made even to the pole itself. As an Arctic explorer, Lieut. Weyprecht did excellent work—discovering Franz Josef Land—and his scientific attainments were undoubtedly of a high order. The views of such a man naturally had great weight, and he advanced such a number of sound arguments in support of his idea that he soon had a number of enthusiastic followers. It is and has been for some time admitted that the laws which govern the winds and the great currents of the sea will never be thoroughly understood until the physical conditions of the polar basin and the movements of the great ice masses are known; therefore the importance of scientific exploration in the polar regions. There are, too, many problems of magnetism and electricity which might have a most interesting solution if experiments to that end were conducted in the far north.

While this plan was being discussed in Europe, Captain H. W. Howgate, of the United States Navy, was urging the government to equip one or more expeditions toward the North Pole, and to establish a temporary colony for purposes of exploration at some point north of the eighty-first degree of north latitude, at or near the shore of Lady Franklin Bay. It was suggested that the party sent out should consist of at least fifty men and should be provided with provisions and necessary supplies for three years, at the end of which period they should be visited, and if still unsuccessful in accomplishing the object, revictualed and again left to their work. He advised that the party should take out with it a strong, substantial building, and had no doubt that the members of the expedition could be made as comfortable and as safe from atmospheric dangers as are the men of the signal service stationed on the summits of Pike's Peak and Mount Washington, or the employes of the Hudson's Bay Company stationed at Fort York, where a temperature of minus sixty degrees is not uncommon. Captain Howgate advised that the principal depot or post should be located upon Lady Franklin Bay between latitude 81 degrees and 82 degrees. He insisted that as Captain Hall went as high as Cape Union (between latitude 82 and 83 degrees) with the Polaris, and Captain Nares still higher in the Alert, a steamship would have no difficulty in reaching the spot. He was particular in pointing out that the only use of the vessel would be to transport the men and the supplies to the location of the colony, and, that being done, to return at once to the United States.

The Gulnare was eventually fitted out, but as she was unfitted for the work the expedition turned out a miserable failure. This incident shows that the project of reaching the pole by means of gradual exploration was entertained in this country at the same time it was receiving the attention of Europe.

By the Meteorological Congress at Rome, the project of Lieut. Weyprecht was referred to an International Polar Conference, held in Hamburg in October, 1879, at which France, Holland, Germany, Austria, Russia, Sweden, Norway, and Denmark were represented. The conclusion arrived at was that the best possible results would be likely to be achieved by exploration around the pole, and that the most practical way of accomplishing this task would be by the establishment of polar stations. A second meeting was held at Berne in the following August, and it was decided that eight stations at least should be provided for. But as only four powers announced that they were ready to immediately do their part, and as there seemed to be a lack of interest shown by civilized nations, the execution of the project was postponed for an indefinite period. The Executive Committee, by vigorous action worthy of the highest praise, prevented the matter from dropping through, infused new life into the project, and by personal interviews and unwearying correspondence attained their long wished for object. The members of this Executive Committee were Professor Wild, of St. Petersburg, who succeeded Dr. Neumayer as president; Captain Hoffmeyer, of Copenhagen, and Mr. Robert H. Scott, the English meteorologist. The United States government entered with spirit into the work, and pledged itself to establish two of the necessary stations

In July, 1881, a third and final meeting was held at St. Petersburg to complete the arrangements. It was decided that the observations at all the circumpolar stations should be begun as soon after August 1, 1882, as possible, and that they should be continued until September in the following year. The stations were finally resolved upon as follows: The United States in Lady Franklin Bay, in Smith's Sound, and also at Point Barrow; Denmark at Godthaab; Germany in Cumberland Sound, on the west side of Davis Strait; England at Fort Rae, in the heart of the Hudson's Bay Territory, near the Great Slave Lake; Russia at the mouth of the Lena and at Moller's Bay, Nova Zembla; Holland at Dickson's Havn; Norway at Bosekop, in the Alten Fjord; Sweden at Spitzbergen; Austria at Jan Mayen Island, famous for its fog and ice. (The small map shows the stations established in the Arctic circle in accordance with the directions of the Polar Conference.) The Finnish Landdag equipped a meteorological station at Sodankyla; a branch station was also established in Labrador. France selected a station near Cape Horn, and Germany also entered into the Antarctic regions by sending a party to one of the islands of South Georgia, in fifty-four degrees south latitude and about eleven hundred miles to the eastward of Cape Horn. These southern stations were to perform the same work in the way of scientific observation as their friends at the north. They were to note carefully all the phenomena, in order that they might be able to compare their results with those of the Arctic stations. The gentlemen in charge of the observatories at Melbourne and Cape Town were also instructed to make a series of observations in connection with the researches of the French and German expeditions. It will thus be seen that fifteen expeditions were arranged for to carry out the plans of the International Polar Commission. Arrangements were also made for the taking of magnetic and meteorological observations at a number of permanent observatories on the 1st and 15th of each month; the same work was also provided for on many ships of war belonging to various countries, and the officers of several merchant vessels were also enlisted in the cause of science.

In pursuance of arrangements made by the United States government, the screw steamship Proteus with the Arctic colony on board, in command of First-Lieutenant A. W. Greely, departed from St. Johns, N. F., on July 7, 1881, bound for Lady Franklin Bay. At Godhaven, fourteen dogs and two sledges were taken on board, as well as several tons of walrus flesh and dried fish to feed them on. Several hundred pounds of white whale skin, famous as an antiscorbutic, were added to the scores. In its dried state it resembles an inferior quality of glue, but when cooked it is said to possess the flavor of tripe. The Proteus reached Upernavik July 24, and sailing on the 29th was put at full speed with her head pointing north. Soon after the 1st of Au-

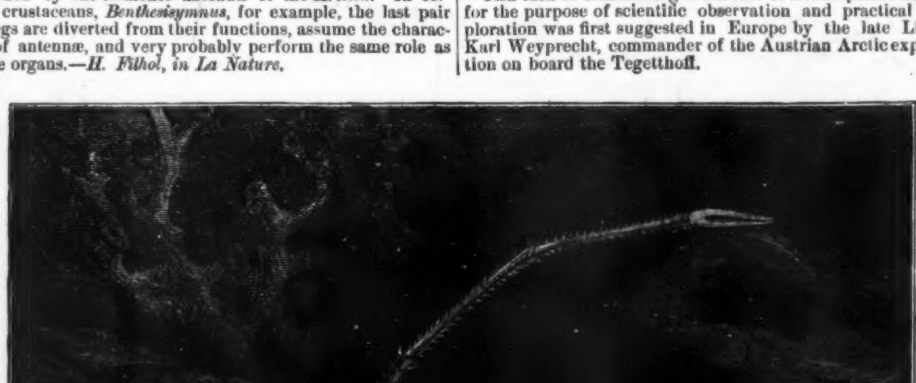
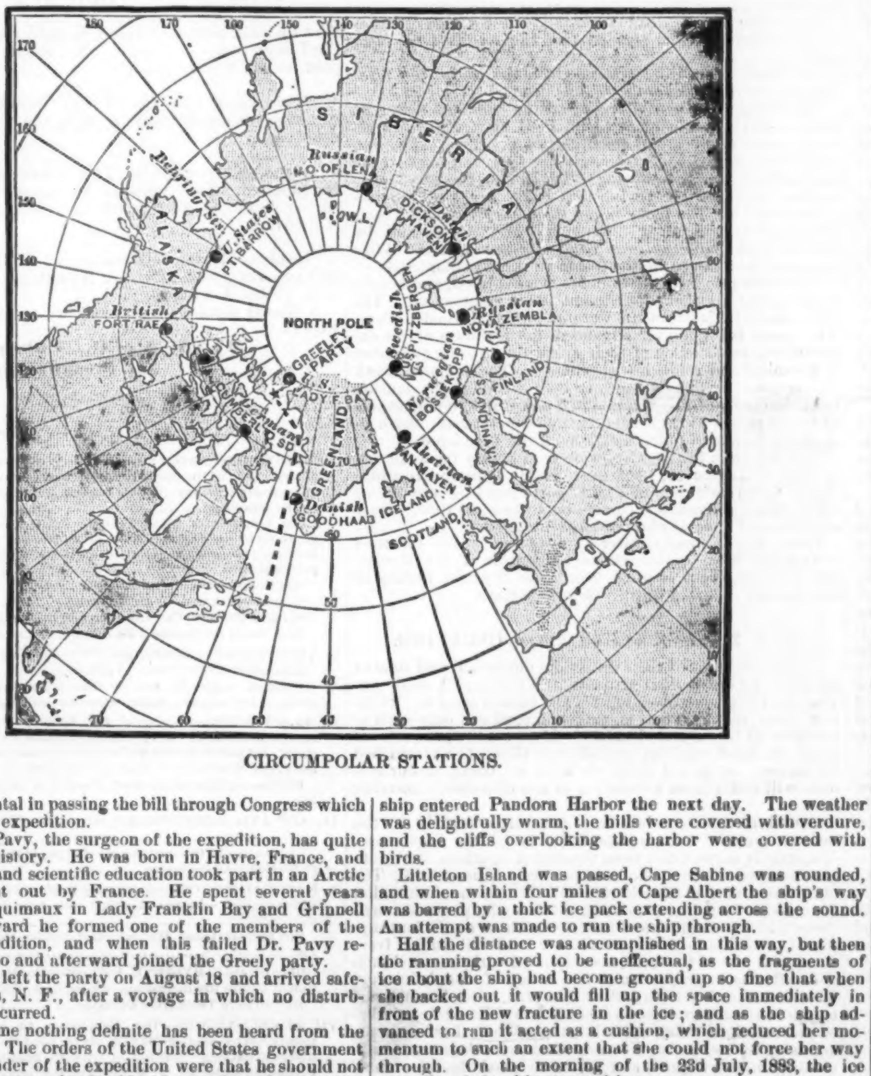


FIG. 3.—PTYCHOGASTER FORMOSUS, A. M. EDW. (Natural Size.)


ARCTIC SEA.
THE CHANNELS
NORTH OF BAFFIN BAY.
BETWEEN
GREENLAND AND NORTH AMERICA.
Compiled from the observations of the latest American and British Arctic Expeditions by the U.S. Hydrographic Office, Navy Department, Commander J. R. Bartlett, U.S.N. Hydrographer.
The Caches are shown thus
LINCOLN SEA
GRANT LAND
United States Range
Yelverton Bay
Challenger Mountains
C. Alfred Ernest
Milne B.
C. Britannia
VICTORIA INLETS
HALL LAND
ROBESON CHANNEL
HALL BASIN
Lady Franklin Bay
ARCHER FIORD
PETERMANN FIORD
KENNEDY CHANNEL
GRINNELL LAND
Victoria and Albert Mts.
JUDGE DALY PROMONTORY
WASHINGTON LAND
NORTH AMERICA
GREENLAND
HUMBOLDT GLACIER
PEABODY BAY
KANE BASIN
Dallas Bay
Rensselaer Bay
Hayes Sound
ELLESMERE LAND
Prince of Wales Mountains
SMITH SOUND
INGLEFIELD LAND
GREAT MER DE GLACE
PRUDHOE LAND
MURCHISON St.
INGLEFIELD G.
WHALE Sd.
Crimson Cliffs
MELVILLE BAY
NORTH LINCOLN
GLACIER STRAIT
JONES SOUND
C. Washington
C. Leopold
LADY ANN STRAIT
NORTH DEVON
BAFFIN BAY

gust the Carey Islands were made, and a party landed on the southeasternmost of the group, where they examined a cairn erected by Captain Allen Young. His records were taken away, and Lieut. Greely left a record of his own voyage in their place. The cache of provisions left by Captain Nares was also found, the puncheon of rum being sampled and pronounced excellent. Later, the Proteus anchored at Littleton Island, where Captain Young, of the Pandora, had deposited his papers and letters for the Nares party, and also where the wrecked Polaris party had passed their second winter after Captain Hall's death. Landing in Life Boat Cove, a demolished cairn was discovered. The next day the Proteus passed the famous Humboldt glacier, which is said to be the largest iceberg "manufactory" in the world. So far the voyage up Smith Sound had been most successful and encouraging. The navigation of the channel since its discovery in 1616 was, until a comparatively recent date, considered impracticable on account of the vast quantities of ice disgorged through it. It remains frozen nearly all the year, the ice breaking up and being carried south for a short time only. The Nares expedition of 1875 made the passage with great difficulty, battling with the ice continually and nearly losing their ships. They were twenty-one days in reaching Cape Frazer from Littleton Island, but the Proteus made the same distance in sixteen hours. After stopping a short time in Coal River Bay, where they landed some stores to be used in case of a retreat, they resumed the voyage. On August 12, 1881, the party was safely landed at Lady Franklin Bay.

The anchor was dropped, and the work of unloading the stores began. The carpenters set to work at building the house, and all progressed merrily. On the day they arrived fourteen musk oxen were killed, which averaged when dressed fully three hundred pounds each. Stores of provisions sufficient to last the party for fully two years were landed. The house erected had double frames, and measured sixty-one feet by twenty-one feet. In addition to the stores and supplies, about one hundred and forty tons of coal were landed at the station, which was christened Fort Conger, in honor of Senator Conger, of Michigan, who had been instrumental in passing the bill through Congress which authorized the expedition.



CIRCUMPOLAR STATIONS.

Dr. Octave Pavy, the surgeon of the expedition, has quite a remarkable history. He was born in Havre, France, and after a liberal and scientific education took part in an Arctic expedition sent out by France. He spent several years among the Esquimaux in Lady Franklin Bay and Grinnell Land. Afterward he formed one of the members of the Howgate expedition, and when this failed Dr. Pavy remained at Disco and afterward joined the Greely party.

The Proteus left the party on August 18 and arrived safely at St. Johns, N. F., after a voyage in which no disturbing incident occurred.

Since that time nothing definite has been heard from the Greely party. The orders of the United States government to the commander of the expedition were that he should not only make a series of scientific observations, but that he should explore as large an area of the polar region as he should find practicable. He was to remain until last fall, when it was arranged that a relief ship should be sent for him.

In June, 1882, Mr. W. M. Beebe took command of a party which sailed from St. Johns, N. F., on July 8, 1882, to take supplies to Lieut. Greely. The Neptune, the vessel that took the party, met with heavy gales and a rough sea, and five days after starting encountered the first field ice. At Godhavn a quantity of supplies was taken on board, and on July 29, 1882, she resumed her dreary voyage northward. The Neptune reached Littleton Island, but the commander found that immense packs of ice completely blocked all further passage north. On August 31 a cache was established upon Cape Sabine, the northernmost land attained by the relief party. The stores and whaleboat were placed in a sheltered spot, well secured, and covered by a tarpaulin. A tripod made of scantling, with an oar attached, to which pieces of canvas were well nailed, was placed upon a prominent point, showing well from the northward, and securely anchored with rocks. In a cairn beneath was placed a record giving the bearings of the cache. A cache was next established on Littleton Island. The stores were landed in a cove at the north end of the island, so well concealed as to be invisible from any point a few yards distant, and covered with a tarpaulin securely anchored down with rocks. Copies of the record, with minute directions for finding the stores, were placed as directed in Lieutenant Greely's letter of the preceding year—two in the coal at the southern end of the island and one in Captain Nares' cairn on the summit of the southwest part of the island. As a last resort the remaining whaleboat was placed on Cape Isabella, its location being marked by a tripod showing well to the northward. Mr. Beebe then called a consultation, and all were unanimously of opinion that further delay was both useless and dangerous, and that everything had been done to carry out General Hazen's orders, and that the safety of the ship and the lives of all on board demanded an immediate departure.

It will be seen that the Neptune did not come nearer Lady Franklin Bay, where the United States circumpolar station is located, than a distance of 100 miles, which is quite a serious distance in Arctic regions. In a communication dated August 15, 1881, Lieutenant Greely stated that in his opinion a retreat southward from Lady Franklin Bay to Cape Sabine would be perfectly practicable in case no vessel could reach them in 1882 or 1883.

The second party sent to the relief of Lieut. Greely was commanded by Lieut. E. A. Garlington. On the 29th of June, 1883, he sailed from St. Johns, N. F., on the steamship Proteus, the same vessel that carried Greely and his men to Lady Franklin Bay. The United States steamship, Yantic, accompanied the Proteus as a supply ship and base. Godhavn Harbor was entered on July 7, coal bunkers were filled, stores for the Greely party were taken on board, preparations were made to form depots, and everything was got in order for the voyage. The Yantic arrived on July 12. Two days later twenty-one Esquimaux dogs were taken on board, and on July 16 the Proteus sailed, leaving the Yantic in port.

On the third day the Proteus was stopped by an impenetrable ice pack. A lead to the west was discovered, and on the 21st Southeast Carry Island was reached, the cache of the Nares expedition being plainly in sight on the end of the island. The stores were found to be in good condition. The ship entered Pandora Harbor the next day. The weather was delightfully warm, the hills were covered with verdure, and the cliffs overlooking the harbor were covered with birds.

Littleton Island was passed, Cape Sabine was rounded, and when within four miles of Cape Albert the ship's way was barred by a thick ice pack extending across the sound. An attempt was made to run the ship through.

Half the distance was accomplished in this way, but then the ramming proved to be ineffectual, as the fragments of ice about the ship had become ground up so fine that when she backed out it would fill up the space immediately in front of the new fracture in the ice; and as the ship advanced to ram it acted as a cushion, which reduced her momentum to such an extent that she could not force her way through. On the morning of the 23d July, 1883, the ice opened and the ship steamed into open water.

On the same afternoon the ship was brought to a standstill, lying due east and west. The ice in front and along the track she was following began to show signs of enormous pressure. A nip was imminent. The Neptune had been beset in nearly the same position the previous year; but had withstood the strain, rising three feet, getting through without damage. The pressure against the sides of the Proteus increased, the heavy ice (from five to seven feet thick) broke, and rafted up on the floe amidships and astern. But still there were no signs of giving way. Meanwhile Lieutenant Garlington's men were getting the stores on deck in readiness for an emergency. All at once there was a loud crash. The ice had forced its way through the ship's side into the starboard coal bunker. The deck planks began to rise, and the seams to open out. All the stores on deck and those near at hand in the hold were now thrown on to the ice, and two boats were also lowered on to the floe. These were the starboard whaleboat and the dingy. The port whaleboat was jammed, and resisted all efforts to move it. The ship now began to settle. The cry was raised, "She is sinking!" All hands left her, but as she settled only a few inches there seemed to be no immediate danger. Making a great effort, the enlisted men, assisted by members of the crew of the Proteus, got the port whaleboat clear. The instruments and records were got on the floe. At a quarter past seven in the evening the ship sank, Cape Sabine bearing N.N.W. ½ W., distant six miles. The efforts of the party were then directed to saving the stores and preparing for the retreat, which all hands, after many perils, succeeded eventually in making good.

Lieutenant Garlington left the following stores of clothing for the Greely party in a cache on the rocks in Payer Harbor: Blouses, trousers, flannel shirts, woolen and rubber blankets, stockings, mits, buffalo overcoats, fur caps, flannel drawers and undershirts, all wrapped up in rubber blankets, covered with a tent fly, and weighted down with rocks. This supply of clothing was sufficient for twenty-five men for six months. Near this cache a new topsail and two bolts of new canvas were also left.

In a cove about three miles west of Cape Sabine a cache of provisions was made which contained fifteen sleeping bags, 600 pounds of hard bread, a quantity of bacon, 700 cases of canned meats, vegetables, and fruits, a box of gunpowder, a can of matches, a tin pot, and a quantity of clothing.

In a conspicuous cairn on the top of Brevoort Island, built for the Nares expedition, Lieutenant Garlington deposited a definite description of the locality of the caches of clothing and provisions.

Another effort is now being made to reach Lieut. Greely. Three ships, in command of Commander W. S. Schley, have been dispatched by the government, the last ship sailing from New York May 10, 1884. During the past few weeks these ships—the Thetis, the Bear, and the Alert—have been thoroughly overhauled at the Brooklyn Navy Yard, have been strengthened as much as possible, and have been furnished with every appliance which would add to the safety of their crews and aid them in accomplishing the dangerous task set before them.

The Thetis is the flag ship of the expedition. She was, until purchased by the government, a Dundee steam whaler. She is of great strength, an excellent sea boat, and capitally adapted for the present voyage. Like all vessels constructed for the whaling business, she is no beauty, but what she lacks in symmetry of shape she makes up in seaworthiness and solidity. She is of about 600 tons burden, 181 feet long, 29 feet beam, and her depth of hold is 21 feet. Her engines are of 98 nominal horse power, and under favorable circumstances can steam from six to eight knots an hour. She was built two years ago, and the price paid for her was $140,000. On February 29 she sailed from Dundee for New York, under the command of Lieutenant L. L. Reamy, of the United States Navy. She experienced heavy gales on the voyage, and was driven far to the northward. In latitude 46 deg. 20 min. north and longitude 47 deg. 14 min. west a field of ice was encountered twenty-five miles wide. The Thetis was rammed though it. The hatches were battened down for twenty days, big seas sweeping her decks fore and aft. The ship was not in the slightest degree injured by sea or ice, the only mishaps which occurred being the smashing of a whaleboat and the washing away of one of the sidelights. The Thetis was admitted to be the stanchest and most serviceable vessel in the Dundee whaling fleet. She was inspected in behalf of the government by Lieutenant Commander E. E. Chadwick, naval attache of the American Legation at London, assisted by Mr. Leigh Smith, the well known Arctic explorer. Since her arrival at this port on March 22, she has been thoroughly overhauled at the Brooklyn Navy Yard. New decks have been put in, and extra diagonal and athwart ship braces have been added. She is bark rigged with unusually large spars for a steamer. The detail of officers for the Bear is as follows:

Commander W. S. Schley, commander; Lieutenant Uriel Sebree, executive; Lieutenant E. H. Taunt, navigator; Lieutenant O. C. Lemly, Ensign C. H. Harlow, Passed Assistant Surgeon E. H. Green, and Chief Engineer George W. Melville.

The steamer Bear was a steam sealer hailing from Dundee, where she was built some nine years ago. She is of 648 tons burden, heavily timbered and strongly bolted. She is, if possible, uglier to look at than the Thetis, but is doubtless a strong and serviceable craft. A year ago she was fitted at Greenock with a new steel boiler, and her engines, of 110 horse power, are in good condition. She has three masts, is bark rigged, and can steam about eight knots an hour in smooth water. She too has been thoroughly overhauled and refitted. The detail of officers for the Bear is as follows: Lieutenant W. H. Emory, commander; Lieutenant J. H. Crosby, executive; Lieutenant John R. Colwell, navigator; Lieutenant N. R. Usher, Ensign L. K. Reynolds, Passed Assistant Surgeon H. E. Ames, and Chief Engineer John Lowe.

The steamer Alert is the gift of the British government. The hull of the Alert looks to be immensely strong, and a close examination shows it to be as strong as it looks. She is bark rigged, and not heavily sparred. There is an arrangement, similar to one on the Bear, for shipping and unshipping the propeller. Two stout davits project over the quarters, for hoisting up the rudder in case of need. The Alert's dimensions are: 175 feet over all, 160 feet on the water line, 33½ feet beam, and 17 feet depth of hold. She has direct acting engines with compound cylinders, capable of developing 570 horse power. Her mean speed is about 17·6 knots per hour. Before the Alert was transferred to the United States government she was completely overhauled. Her defective timbers were replaced by sound ones, and the sheathing of teak from seven to four inches wide, extending from the keel to the water line, was put on. She was strengthened by extra beams and iron knees. Her bows are strengthened by solid beams and sheathed with iron. Felt is placed between the inside planking and the lining to keep out the cold, and the ship is divided into water tight compartments. The Alert was formerly a sloop-of-war in the British Navy, and was built in 1856. She was the advance ship of the expedition of Sir George Nares, in 1875–76, and as such went nearer to the pole than any other vessel has ever been before or since. By direction of the Queen the Alert was, on February 22 last, presented to the United States government.

The detail of officers of the Alert is as follows: Lieutenant-Commander George W. Coffin, commanding; Lieutenant C. J. Badger, executive officer; watch officers, Lieutenant H. J. Hunt and Ensigns C. S. McLane and A. A. Ackerman; chief engineer, W. H. Nauman; passed assistant surgeon, F. S. Nash.

Just before the departure of the vessels the provision storehouse at the Navy Yard presented a curious spectacle. The first floor was covered with heaps of casks and kegs, iron bound and filled with fruits, meats, and vegetables of about every eatable kind, from the beef and tallow mixture called pemmican to oysters fried to a turn, and from cold Irish potatoes to currant jelly and raspberry jam. Each keg was labeled with the name of the steamer it was intended for, the name and quantity of the contents, and the words

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"First year" and "Second year"—the supplies to be used in the years indicated. The extraordinary care taken in packing the goods in air-tight kegs was necessary to insure that nothing should be spoiled while lying in the ship's hold awaiting use. The storehouse also contained immense boxes of clothing for the men. Long red woolen stockings, short woolen foot mitts, long thick overstockings that lace up in the instep, and great sealskin boots, lined with lamb's wool, will clothe the feet of the men when on duty about the deck, a rubber slipper, with a sole like a door mat, going on over the boot, to keep the sole off the ice and the foot from slipping. The soles of the boots measure 5½ inches by 13. There is nothing peculiar about the underclothing furnished to the men, unless it is the unusual thickness and fine quality, but the trousers are made close fitting around the calf, so that they will slide into the boots easily. For trips across the ice, long-legged leather boots that lace in the instep and have ice creepers on the sole are supplied.

Of all the supplies that convey the idea of warmth and comfort in a blizzard, the deerskin suits and the sleeping bags of the same material are the chief. The coats are made on the pattern of a shirt, with flaps in front and rear like a Chinaman's blouse. The ends of the sleeves are fitted close to the wrist. A hood comes up over the neck and head and buttons under the chin. The trousers are in shape much like common ones. The suit is worn with the fur outside. It is said that five minutes in it in this latitude is equal in its effects to a Turkish bath. The sleeping bag is a sort of close-fitting, flexible coffin, with a short slit from the hole that represents the face plate down, and a fur flap to cover the hole. The slit is closed by buttoning one side over the other. The buttons are wooden toggles two inches long, and the buttonholes are loops of silk cord.

The spare clothing is packed in bundles by wrapping up several suits in paper, and then placing them in hydraulic presses with pieces of oil cloth above and below. The bundles were then squeezed down to about one-fourth their original size, and the oil cloths stitched together over the paper wraps. Then the seams were smeared over with white lead to make them air tight, and a coarse canvas cover stitched over all. Then on the outside of each bundle was painted the name of the ship for which it was intended, the contents of the bundle, and the words "First year" or "Second year."

Each ship carries two boats 28 feet long, and three 24 feet long. Side keels are bolted under the bilges of each boat to serve as runners when the boats have to be transported over the ice. Stanchions two feet high are placed at intervals along the rail, by which canvas screens can be stretched to protect the men. Two masts, with triangular sails that can be easily raised or lowered, go with each boat. If the party is obliged to stop on the ice, a mast can be laid on two stanchions amidships, when it will serve as a ridge pole for a tent that can be made of the sails. Besides a full set of common oars, each boat is furnished with a set of paddles, with small, thick blades on one end and sharp chisels on the other, to poke or cut away cakes of ice. The dories have only one mast. All the boats are furnished with lockers along the sides. The steam launches are a little broader than those built at the yard. They are provided with an ingenious device by which the rudder can be shipped to a certainty, no matter how rough the sea may be, or how dark the night. When the boats are hauled upon the ice, the rudder attachment becomes an excellent sled runner. The launches can be housed over with canvas.

The sleds are double enders, and, before loading, either side will serve as the top. They are made of bent hickory, iron shod, and are probably the best than can be made for the purpose. They are about ten feet long, a foot high, and two and a half wide.

Each vessel is amply provided with ice saws—blades of steel from ten to twenty feet long, three inches wide, with teeth two inches long and an inch deep. The handles at one end are long enough for four men to get a hand hold, while an iron crane can be so secured as to assist in jigging the saw up and down. It sometimes happens that a crew can see an ice floe coming miles away. By sawing out a large space in one side of the floe, beside which the vessel is moored or is sailing, they can make a dock into which the vessel can be warped. The two floes expend their power on each other while he ship rides in safety in the open space. But the slow work of the saws will not be the only dependence in case of immediate danger from a nip between floes, as, for the first time in the history of Arctic expeditions, gun cotton cartridges will be used for blasting out harbors. A train of the cartridges, which are about twenty-four by three and one-half inches, can be laid around a space five hundred feet long by sixty wide in a very few minutes. Electricity will explode the cartridges, when the vessel can steam into her harbor without difficulty. Each vessel carried 2,000 cartridges.

The Alert will be used as a supply ship, and on the relief expedition will go no further north than Littleton Island. An endeavor will be made to so time her movements that she will reach Littleton Island about July 1, in order to have sufficient time to land and build house, land provisions, coal, and other supplies to establish the station upon which the advance ships can retreat in the event of disaster, and afterward to send a sled party onward to examine the coast on the eastern side of Smith's Sound as far as Humboldt Glacier. Should neither the Thetis nor Bear return to Littleton Island by September 1, the Alert will return to St. Johns with news of the expedition.

The Bear sailed from the Brooklyn Navy Yard April 24, 1884. The Thetis sailed May 1, and the Alert May 10. The general plan of the expedition, as expressed by Commander Schley in a letter to the Secretary of the Navy, will be for the Bear to reach St. Johns, N. F., to fill up with coal, take dogs on board, and to inquire into the condition of the ice in Davis Strait, and at the earliest practicable moment to push onward to the Disco and Upernavik, Greenland, reaching there about the third week in May, if possible. The Thetis, following the Bear, will stop at St. Johns for coal, to take on dogs, and to convey the coal steamer to Upernavik, where she ought to arrive at about May 25.

From Upernavik the Thetis and Bear should proceed onward with the convoy to Cape York and Littleton Island; should the ice appear too formidable for the collier to encounter so early as June, she should remain at Upernavik until the arrival of the Alert, which vessel should then be charged with the convoy.

The present expedition is probably the best equipped one that ever started for the polar regions, and is prepared to run all reasonable risks in order to save the explorers or to ascertain what has become of them. Every precaution will be taken to insure the safety of the officers and men, so that the effort to save those already in peril may not result in the unnecessary hazard or sacrifice of additional lives. The large map shows the routes taken by former exploring expeditions and the location of Lieut. Greeley's station.

We may briefly add an account of what has been done at the other circumpolar stations. The Polar Commission in its instructions to the commanders of the various expeditions, divided the observations to be made into two classes—the voluntary and the obligatory. The obligatory class was divided into four branches—meteorology, magnetism, aurora, and astronomy. The voluntary observations, the taking of which, though not absolutely insisted on, was warmly advocated, included almost every phase of natural science, such as temperature of the soil, snow, and ice, above and below the surface, evaporation, terrestrial magnetism, galvanic earth currents, auroral phenomena, hydrographical, spectroscopical, and pendulum observations; atmospherical electricity, inquiries into the growth, motion, and structure of ice; the physical properties of sea water, as well as a number of other valuable and interesting investigations. It was suggested also that samples of air and water should be procured for analysis, and that collections should be made in the departments of zoology, geology, and botany. The magnetic and meteorological observations, being of the greatest importance, were insisted upon, and the other branches of inquiry, which, of course, would depend on various circumstances, were left to the discretion of the members of the expedition.

Detailed reports sent home by Herr Sophus Tromholt, from the Finnish station at Sodankya, are startling in the novelties they contain. He experimented almost on a gigantic scale with the aurora borealis. By means of an arrangement of batteries and wires along the face and up to the summit of a hill 1,000 feet high, he was able to produce an artificial aurora differing in no respect in appearance and spectroscopic analysis from the genuine article. He was unable, however, to obtain any photograph, even by using the most sensitive dry plates. Thus brilliant as the northern lights are, the actual amount of light contained in them is exceedingly slender.

The Austrian polar expedition, which returned last August from Jan Mayen Land after an absence of sixteen months, was quite successful. The observations were perfect, their collections rich, and their photographs numerous.

The English contingent at Fort Rae did good work, too. The spectroscopic observations were very satisfactory.

From the latest news regarding the Swedish station at Spitzbergen it is gleaned that the results have been good.

The Danish expedition was caught in the ice in the Kara Sea, and their operations were thus delayed for a year.

The station at Point Barrow, on the northern coast of Alaska, was in command of Lieut. P. H. Rae, who, with his party, spent two years in scientific work. This expedition sailed from San Francisco on July 18, 1881, and reached the station September 8, following. The Golden Fleece, the vessel that conveyed the party, started on her home voyage September 18. The party began the work of erecting their house and securing their instruments and stores; and by October 3 the building was ready for occupation. After the party had moved in, the inside work was completed.

The meteorological instruments were placed, and hourly observations in that department were commenced. The three magnetic instruments were mounted on wooden piers. The season being too far advanced, the members of the expedition devoted much of their spare time to the collection of botanical and zoological specimens. The magnetic work was very trying during the very cold weather, for delicate instruments had to be manipulated and read in temperatures as low as minus 45 degrees. At such times it is of course almost impossible to touch metals with the bare hand.

The magnetic instruments were read hourly from August 1, 1882, to August 13, 1883, over ninety thousand readings being taken and recorded. A corresponding amount of meteorological work was carried on at the same time. Over six thousand auroral observation were made.

Lieut. Rae and party, after a stay of two years, returned in October, 1883, on the schooner Leo from Point Barrow. The men came back in good health, no sickness worthy of note having occurred during the whole time.

HOW TO SAVE TEETH FROM DECAYING.

In the discharge of their duties the physician and dentist are daily asked by their patients, "What shall I do to prevent my teeth from decaying?" The answer must be, "Correct your diet." That is, eat such food and only such as contains all its natural elements. If we eat the products of grain, we must eat them with all their elements as furnished by nature. If we eat meat, we must eat bones, or our systems will suffer from a violation of one of nature's unerring laws.

Dental development in man is discernible as early as the seventh week of intrauterine life; hence the importance of a strictly correct diet from the first if mothers desire to give birth to children who have perfectly formed teeth. The observance of this dietetic rule will furnish the foundation for a good, long framework. A mother who passes through the periods of gestation and lactation without a sufficient supply of tooth and bone material in her food will suffer from decay and loss of the teeth, accompanied with the usual pain and suffering in proportion to the extent of the deficiency. The lime from her teeth will be dissolved, taken into the circulation, and appropriated by the offspring. Excepting civilized man, all flesh eating animals eat as much of the bone of the animals they devour as they can break with their teeth sufficiently fine to swallow, and all have good dental organs. Place before a tribe of Indians everything the earth produces in the shape of food, and they will eat only animal food so long as that lasts; but put them upon a reservation, and feed them as civilized people feed themselves, and they too soon suffer from decay of the teeth. Take from any carnivorous animal his supply of bone which nature furnishes with the meat, and decay of the teeth is sure to follow.

Even our domestic, herbivorous animals thrive better when bone is added to their bill of fare. The cow which every year gives birth to young has an excessive drain upon her supply of bone material, and craves bones to such an extent that she will try to masticate even very large ones, as every farmer's boy can testify.

Veterinary surgeons have long known that certain diseases of their dumb patients can only be successfully treated by feeding to them bone meal. A dam, too aristocratic to gnaw bones, gave birth to successive litters of rickety pups, since which she has been fed with food containing bone meal, and has given birth to perfectly healthy ones by the same sire.

Any person engaged in raising poultry know that their birds must have lime supplied to them, or they will furnish only soft shelled eggs.

Bone is now acknowledged to be the best fertilizer for New England farms. Visit one of these farms in the month of June, and you can count the hills where the corn grew three years before by the spots of grass which stud the earth at regular intervals. The farmer will tell you, "Bone did that."

This evident deficiency in the soil explains the too apparent lack in the products of the soil.

The educated farmer analyzes his soil to discover the elements that produce his crops, and he endeavors to supply all deficiencies. The intelligent stock-raiser studies the requirements of his stock, yet neither appears to realize the greater importance of carefully regulating his child's diet and of diligently supplying to him all of the needed elements. Arguments in favor of eating bone to prevent decay of the teeth as well as to cure a long catalogue of bone and other diseases might be continued indefinitely, but as "a word to the wise is sufficient," it seems only necessary to add that a long continued experiment has been made upon a family with results which fully justify these claims. The bones were selected from perfectly healthy animals, none being used that bore any blemish of abnormal growth, carefully cured, without being allowed to pass through any perceptible chemical change, finely granulated, and incorporated into soups, gravies, bread, etc., in the proportion of from one to two or three spoonfuls to each pint of soup, gravy, or flour.

The relative proportion of nutritive elements in one hundred parts of different kinds of animal food has been found as follows: beef 26, pork 20, chickens 27, mutton 29, brain 20, blood 21, codfish 21, white of egg 14, milk 7, bone 51.

H. E. D.

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